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Original Articles

SOME COMMON INDIAN BIRDS.

No. 2. THE BLUE-TAILED BEE-EATER (*MEROPS PHILIPPINUS*).

BY

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Imperial Entomologist;

AND

C. M. INGLIS, M.B.O.U.

Our last paper[1] dealt with a useful bird—useful, that is, so far as agriculture is concerned—but the same adjective cannot be applied to the Blue-tailed Bee-eater, as it is on the whole an injurious species by preying on beneficial insects.

In appearance and habits it is much like its commoner and smaller, but equally noxious, relative, the Common Indian Bee-eater (*Merops viridis*), from which it is distinguishable by its chestnut throat (green or bluish-green in *M. viridis*). It is shortly described by Dewar (*Indian Birds*, p. 161) as "general hue green, shot with bronze; the tail is bluish. There is a broad, black streak running through the eye. The chin is dirty cream colour. The throat is chestnut-red. The eye is bright red."

The Blue-tailed Bee-eater occurs commonly throughout the Plains of India but is partially migratory, visiting Northern India in the summer and Southern India in the winter. In Bihar they are seen from March to October and in the Duars have only been

[1] *Agric. Journ. of India*, XV, 1.

noticed during June and July. Mr. Stuart Baker only once came across it in North Cachar. Usually it is seen in small numbers or singly in one place but occasionally it congregates in large numbers. As a rule it is commonest in well-wooded districts. It is fond of perching on a post or telegraph wire or other suitable situation whence it swoops down on its prey which is usually captured on the wing, the bird thereafter returning to its perch. The flight is swift and graceful and the note a mellow whistle continually uttered while on the wing. During evenings, especially after rain, numbers may be seen hawking about on the wing for a long period without settling.

This Bee-eater is common at Pusa and the late C. W. Mason examined the stomachs of thirteen birds between April and October. He states[1] that, of 83 insects taken, 70 were beneficial, 3 injurious and 10 neutral. The beneficial insects taken included dragonflies, honey and other bees, and wasps, and in the neighbourhood of an apiary these birds may be a decided pest by snapping up the bees.

Breeding occurs, usually in large colonies, some time between March and June, in a hole which may be four to seven feet long with a diameter of two to two-and-a-half inches and which is excavated in a bank, usually a river bank though not always so, the egg-chamber being about half a foot in diameter and, what is unusual with bee-eaters, it is sometimes lined with grass or feathers. Four or five and rarely seven glossy, white, almost globular, eggs are laid. Our Plate shows the entrance of a nest.

Besides the present species there are six others found in India and Burma, *viz.*, the Common Indian Bee-eater (*Merops viridis*), a smallish green bird with a golden hue on the crown of the head and the usual black band under the eye. This is the commonest of all the Bee-eaters and as a rule resident wherever it occurs. We shall probably return to it in a later paper. The Blue-cheeked Bee-eater (*Merops persicus*) is very like the Blue-tailed bird but has the upper surface of the tail green instead of blue. This is a migrant from Africa and West and Central Asia to the North-West of

[1] *Memoirs, Dept. Agriculture, India, Ent. Series*, Vol. III, p. 165.

India, breeding there. The European Bee-eater (*Merops apiaster*), a smaller species with a yellow instead of a chestnut throat, is also a migrant from Africa, visiting Kashmir and the Punjab during May and June. The Chestnut-headed Bee-eater (*Melittophagus swinhoei*) has a short tail and is chestnut above: this species is mostly confined to forests. The Blue-bearded Bee-eater (*Nyctiornis athertoni*) and the Red-bearded Bee-eater (*N. amictus*) are stout birds for Bee-eaters, and have, as can be seen by the names, blue and red plumes down the breast; they are green above; these birds are not so graceful in their movements as the other Bee-eaters. Blanford says the nidification of the latter bird is unknown but since then the eggs have been taken in Perak in February; they appear to be smaller than those of the Blue-bearded species.

INVESTIGATIONS CONCERNING THE PRODUCTION OF INDIAN OPIUM FOR MEDICAL PURPOSES.

BY

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AND

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From time to time references have been received from the Opium Department with reference to the supposed increase during recent years in the severity of fungoid attack on the poppy plant. The attack leads to diminished yield and, consequently, to a diminished willingness on the part of the cultivator to grow that crop. It was, therefore, decided to take up the serious study of the poppy plant at Cawnpore. From the mycological aspect the disease had received much attention at the hands of the Mycological Section at Pusa[1]. There remained, however, the study of the poppy plant itself. Since a brief investigation of the plant, carried out by the Howards and Abdur Rahman[2] in 1910, the crop had received no attention from the botanical aspect.

The existence of races resistant to fungoid disease is a well-known phenomenon and the isolation and multiplication of such races has formed a marked feature of the work of many of the American agricultural stations. Biffen's work on wheat is an

[1] *Report of the Agric. Res. Inst., Pusa,* 1913-14, 1914-15 and 1915-16.

[2] *Memoirs of the Dept. Agric. in India, Bot. Series,* Vol. III, No. 6, p. 321.

example of this class of work carried a stage further. Biffen has succeeded in combining the disease-resistant character of one wheat with economic characters, such as strong straw and 'strength,' exhibited by other classes of wheat, into one individual from which, by multiplication, a seed supply sufficient to sow extended areas has been produced. It seemed more than probable that a similar study of the poppy plant would, in like manner, lead to the discovery and isolation of disease-resistant races from the poppy crop.

It is a recognized fact that field crops, as grown by the cultivator, are, with the rarest exceptions, mixtures. It is almost invariably possible to isolate from a single field a large number of types differing from each other both in structure, in habit and in quality of the produce. There appeared no a priori reason why this should not equally be the case with the poppy crop, and a preliminary examination of the cultivators' fields only strengthened the conviction. In its initial stages, therefore, the investigation was confined to the isolation of as many types as possible from the crop as generally grown, with the object of obtaining, from among these, certain types that showed a natural resistance to the disease responsible for such widespread loss.

In the year 1915, the investigations received a different orientation. In pre-war days the opium produced in the Balkans and Asia Minor, which normally contains 12 to 14 per cent. of morphine, practically held the monopoly of the medical opium market. When Turkey and Bulgaria entered the war against us, supplies of medical opium failed, a failure which synchronized with the time when the demands of ourselves and our allies were greater than ever. Indian opium in the past has been distinguished by its low morphine content, which has been stated to be about 8 per cent.; and, mainly for this reason, it was not employed for medical purposes in pre-war days. The problem, therefore, of raising the morphine content of Indian opium, which had been put forward at intervals since the early nineties, became acute. There was, moreover, the additional incentive that the trade might be retained permanently after the war.

In the manufacture of opium alkaloids British firms have been able easily to defy competition. At least 90 per cent. of the opium sold for medical purposes is used for the manufacture of alkaloids, and the remainder for druggists' requirements in powders, tinctures and such like. For the former purpose, the manufacturers naturally desire opium of high alkaloidal content. For the latter, there is little market for opium containing less than 9½ per cent. morphine in the dry opium, since the British Pharmacopœia lays down that opium used for pharmaceutical purposes must contain between 9½ and 10½ per cent. of morphine. Opium of higher morphine content than 10½ per cent. may be reduced to the required standard with opium containing less than 9½ per cent. of morphine. The scope of the investigations was, therefore, extended with the object of removing the disabilities under which the Indian produce laboured as a source of opium for medical purposes and the present article summarizes the progress of this aspect of the work.

Botanical.

The general lines along which the botanical investigations have been developed have been already stated. As conceived, it consisted in the isolation of pure races with a view to the introduction of disease-resistant cultures. Subsequently selection was extended to the development of races yielding opium of high morphine content. Further, sight was not lost of the possibility of developing work along the lines so successfully employed by Biffen in the case of wheat.

For the purposes of this investigation large numbers of samples of seed of the poppy were procured and sown in 1914, while cultures have been made of further samples of seed received yearly. The bulk of these samples were obtained from the poppy-growing tracts of the United Provinces but work was not restricted to these. Seed has been procured from such diverse localities as Malwa—the second largest poppy-growing tract of India—the hill districts round Jaunsar, Persia, Egypt, England—the true opium poppy of the Balkans and Asia Minor kindly supplied by Mr. L. Sutton—and Japan.

The pollen of the poppy is light and dry and may be carried long distances by wind. The flower is, moreover, open and freely visited by bees. Cross-fertilization is, therefore, of frequent occurrence ; as many as 25 per cent. of the offspring of a pure type have, in some cases, been identified as crosses. To guard against such contamination of the pure lines protection has to be rigidly carried out in all work on the crop. With suitable precautions, however, the isolation and maintenance of pure races is not a matter that presents any great difficulty.

From the preliminary sowings of the seed so procured a series of single plant cultures were raised which included all the forms recognizably distinct and gave a very fair indication of the differences to be found in the poppy as grown by the cultivator. The preliminary cultures at once indicated the correctness of the supposition as to the mixed nature of the crop. They indicated yet another point frequently met with when the vernacular names of races are considered ; namely, that the name applied to one race in one tract is applied to another race in another tract. To such an extent is this the case with the poppy that different officers of the Opium Department, intimate as is their knowledge of the plant, have frequently, when visiting the experimental fields at Cawnpore, applied different names to the same culture. This is no slight on the officers of that department ; the diversity of name is due to the diversity of the districts in which those officers serve. It emphasizes, however, the unreliability of vernacular names as a guide to accurate work and of the use of such names as a basis for accurate conclusion.

These cultures further indicated, what is also commonly found in such cases, that, while purity is rarely, if ever, found in the field, a fair degree of purity is of common occurrence. Stated in another way, a culture frequently shows a dominant type to which the name used by the cultivator may be presumably applied. A few examples taken from a large number of analyses of preliminary sowings will indicate the degree of reliability that can be placed on the interpretation of vernacular names.

Percentage of different types found in different cultures of the poppy plant.

	Variety name	Types 1	2	3	4	5	6
1	Bharbharwa	10	20	..	..	Few	70
2	Do.	80	Few	..	..	..	20
3	Do.	Few	100	..	..	..	..
4	Do.	45	45	..	..	..	10
5	Do.	95	5	..	..	..	..
6	Do.	75	5	20	..	..	..
7	Katela	20	40	..	..	Few	40
8	Do.	90	..	..	10	..	..
9	Do.	10	20	..	..	..	70

In the above table the types are referred to by numbers for the sake of simplicity but type 6 is the typical *Katela* plant. The eighth sample, therefore, contains no *Katela* plants at all though the seed bears that name. A comparison between samples 1 and 9 illustrates a further point. These samples bear different names yet the two are composed of practically identical mixtures.

From the single plant cultures so raised with every precaution against accidental cross-fertilization it has been possible to select out a large number which showed every indication of purity. These cultures, in their turn, have formed, on the one hand, the basis of the chemical work and have provided, on the other, an indication as to the degree of susceptibility of the different types to disease. Differences occur in such morphological characters as leaf shape; colour of stem, green or blackening on ripening (*Kali Danti*); height of stem; shape and colour of petal; shape and surface of the capsule, waxy or shining (*Telia*) and colour of seed; while, in addition to the question of disease, marked differences in the time of maturation and in susceptibility to insolation occur among the physiological differences. Chemical analysis of the opium derived from these pure cultures has indicated that the racial diversity in morphine content is large. Races have been isolated which have as high a morphine content as 20 per cent. while, at the other extreme, are races yielding only 6 per cent. morphine in their opium.

A large proportion of the races yield opium containing more morphine than that required by the British Pharmacopœia standard for medical opium. Selection for vigour and disease-resistance in combination with a high morphine content has not, therefore, been a matter of extreme difficulty. It has, in fact, been possible to isolate suitable races directly and without recourse to synthesis of a plant by the union of characters previously not found in combination. The elimination of this necessity has simplified the problem from the breeder's point of view though the scientific interest attached to the successful union of such intangible characters remains.

Chemical.

The desirability of determining the extent to which the capacity to produce an opium having a high morphine content could be considered a plant character was early evident and the earliest chemical work was devoted, therefore, to the examination of the opium derived from the 500 odd pure races of which the opium had been extracted. The analytical work involved in this work was, naturally, considerable ; but the results shewed that there was a considerable variation in morphine content of the opium of the different races. Reckoned on the dry opium, the morphine content varied from 6·5 to 20·5 per cent. A number of these pure races have been grown in three successive seasons in order to see whether there is any seasonal variation involved. The results of the work are, in this respect, incomplete but, in many cases certainly, a race producing opium of high morphine content has maintained this character. On the other hand, it must be admitted that there are many cases in which opium produced from the same pure race varies considerably in its morphine content in successive years. It must be remembered that purity in this case has been determined on morphological, and certain obvious physiological, characters only. That certain of the races, apparently pure when judged by these standards, should prove to be impure with respect to less obvious characters need not be a matter for surprise ; and the results so far obtained would appear to point to the probability that the production of opium with high or low morphine content is a race character.

Fortunately the first season's work supplied the explanation of the reason why Indian opium was generally found to possess a low morphine content. But before dealing with this it will be convenient to indicate the manner in which opium is obtained from the poppy capsule. About 12 to 18 days after the fall of the petals, the capsule is ready for lancing. The cultivator recognizes the correct stage of ripeness mainly by touch. He uses a knife built up of three or four parallel blades, with sharp points set about 1/16 inch apart. This knife is drawn carefully and vertically over the surface of the capsule while care is taken that the points do not incise too deeply. The incision is made in the early afternoon and early the next morning, after the dew has evaporated, the coagulated latex is collected and stored in earthenware vessels. The capsule is lanced again at successive intervals of three days as long as it will yield latex. At times each capsule will receive as many as eight successive lancings in this manner. The produce of all these lancings has, in the past, been mixed together by the cultivator before the opium is made over to the opium officer.

The produce of each successive lancing has been examined separately for morphine content. The results of this examination proved to be of considerable interest in that they afforded an explanation of the generally low morphine content attributed to Indian opium. The morphine content of the opium was found to diminish rapidly at each successive lancing. The appended figures are typical of the many hundreds of determinations made.

Morphine per cent. in the opium from successive lancings of the same capsules.

Series	No. of lancing				
	1	2	3	4	5
I	14·3	11·3	8·9	5·7	—
II	16·7	14·5	10·5	8·2	—
III	11·5	8·6	5·7	3·5	1·5

The fall in the morphine content of the opium of each successive lancing is striking. Samples of opium from the fifth lancing which

yielded no morphine by the ordinary methods of analysis have been met with.

In Asia Minor and the Balkans each capsule receives only one lancing and herein lies the simple solution of the problem why the produce of this area is so much higher in morphine content than that of Indian opium in the past.

Another very important factor which must be taken into consideration in any work on opium has also been elucidated. It is that the number of capsules borne on a plant influences the morphine content of the opium produced. Thus the opium of the first capsule to appear—the terminal capsule—is much richer in morphine than that from the capsules subsequently formed—the lateral capsules—on the same plant. The following figures, selected at random, from numerous similar sets illustrate this point.

Morphine content of opium of each successive lancing.

Serial No.	Description	No. of lancing				
		1	2	3	4	5
I	Terminal capsules	14·0	8·4	5·3	3·3	—
	Lateral capsules of same plants ..	12·2	7·1	4·9	—	—
II	Terminal capsules	15·7	12·3	7·5	9·4	2·8
	Lateral capsules of same plants ..	8·2	5·0	1·6	1·3	0·0

This line of work obviously indicates that, in order to procure opium of the highest morphine content, it is desirable to develop a race which produces only one capsule per plant. Recognition of this factor is also of much importance in any work on the poppy latex and allowance has been made for it in later work.

The effect of climate on the morphine content of opium has also been investigated. Opium of high morphine content has been produced in all countries, *e.g.*, Sweden, Germany, France, the United States of America, Africa, Egypt, Turkey and Japan. Hence it hardly seemed likely that climate was a ruling factor. In these experiments the same pure race has been grown at various places in the plains and at various altitudes in the hills. These experiments have been continued for three seasons. Stated briefly,

the various conditions under which the plant has been grown have exerted no marked effect on the morphine content of the resulting opium. Sudden changes in weather conditions, however, affect the yield of latex. For instance, east winds and cloudy weather diminish the yield of latex but do not influence its morphine content. A similar effect has been observed by one of the writers (H. E. Annett) in the flow of palm juice.

The effect of various manures has been carefully studied. Of the various mineral manures used at Cawnpore only nitrogenous manures appear to have an appreciable effect. Nitrate of soda increases the yield of latex considerably, in fact almost doubles it; but the percentage of morphine in the latex is not altered to a significant amount. The effect of nitrate is to increase the size of the capsules and not to increase their number.

It is not possible to enter in detail into the numerous other observations which have been made. The influence of the age of the capsule at the time of lancing has been studied and it has been found that very young capsules, say 5 or 6 days old, produce opium of low morphine content; but, after this age, the morphine content of the latex is more or less constant, however old the capsules may be. Moreover, the morphine content of the latex diminishes in the later runnings from the same cut surface. The effect of different methods of lancing has also been studied in detail and has led to interesting information relating to latex flow.

In this account attention has so far been directed only to the question of morphine. But accompanying morphine, in opium, are many other alkaloids, chief among which are codeine and narcotine. As the result of new methods of estimation which have been devised in the course of this work, it has been possible to study the behaviour of these also. They do not behave at all in the same way as does morphine. Thus the percentage of codeine appears to remain constant in the opium from each successive lancing of the same capsule. In this connection an interesting problem, which is now forming the subject of investigation, arises as to why Indian opium is so rich in codeine. It contains 2 to 4 per cent. of this alkaloid whereas Turkish opium contains only

small quantities. The high codeine content of Indian opium brings it much into favour with alkaloid manufacturers since codeine is more valuable than morphine.

The whole work has thrown much light on the function of kalaloids in plant life. The animal takes in complex foods and excretes much of its nitrogen in a simple form as urea. The plant, on the other hand, lives on simple substances and builds up complex compounds. It is not surprising, therefore, that its waste nitrogenous substances are complex in structure; and these investigations point to the fact that the alkaloids represent the useless end products of metabolism. In this connection it may be pointed out that the caoutchouc content of rubber latex appears to show phenomena similar to those exhibited by the morphine content of poppy latex. Thus, in successive incisions made in the same plant for rubber, the caoutchouc content appears to diminish in the same manner as the morphine diminished in successive lancings from the same capsule.

Conclusion.

For some years past work bearing on this subject has been carried out by the Imperial Institute and the latest account appears in the Bulletin of that Institute for January–March, 1919. The work which is there described is open to criticism on several points and the opportunity now offered of referring to it may be taken.

The figures given earlier in this note with reference to the constitution of the field crop indicate the danger of placing any reliance on vernacular names for the identification of a race. In the case of the poppy this is, as has been said, particularly true. In two cases only, the *Kali Danti* (black-stemmed) and the *Baunia* (dwarf) are the names applied with any certainty, while the name *Katela* is used indifferently for at least two entirely distinct types. It must not be forgotten, further, that the cultivator will apply a name to his crop, however complete the mixture of types he is growing may be. The pure cultures which have been subjected to chemical test and which include every recognizable type of plant, indicate the existence of little or no correlation between the type,

in the morphological sense and as recognized by the cultivator, and the morphine content. The recommendations based on the use of vernacular names and particularly that made on page 11 of the article under reference "that the varieties noted on page 8 and 9 are well worth consideration for cultivation purposes" would appear, therefore, to rest on singularly insecure foundations.

It may, further, be noted that no information is given with regard to the origin of the samples in respect to the lancing from which they were derived. In view of the absence of this record, it must be assumed that this point was not considered and that the history of the samples in this matter was not recorded. It is far from likely that, unless especial precautions were taken, these would all contain yields from the same number of lancings since frequently the capsules dry up after a second lancing in one district, whereas, in a neighbouring district, they may yield as many as five successive lancings. The variations recorded in the course of that paper are now known to be fully within the range given by different lancings of the same plant and may be as readily ascribed to this cause as to racial, or soil, differences. The problem under consideration is, in fact, typically one which can be studied only on the spot.

THE ELEVENTH MEETING OF THE BOARD OF AGRICULTURE IN INDIA.

BY

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Second Imperial Mycologist.

THE eleventh meeting of the Board of Agriculture was held at Pusa from 1st to 6th December, 1919, under the presidency of Mr. James Mackenna, Agricultural Adviser to the Government of India. There was an exceptionally large attendance of members and visitors, the latter including, besides the Hon'ble Sir Claude Hill and the Hon'ble Mr. R. A. Mant, Mr. Lewton-Brain, Director of Agriculture, Federated Malay States, and the members of the Indian Sugar Committee.

The first day's proceedings opened with a speech from Mr. Mackenna, in which he made a survey of the more important events affecting the Department of Agriculture during the past two years. Since the last Board, sectional meetings of workers in chemistry, mycology and entomology had been held and had been an unqualified success. Provincial Boards of Agriculture, to meet annually, had been formed in some provinces and it was hoped that, by solving questions of purely local importance, they would materially lighten the labours of the full Board. In conclusion, the President dwelt on the approaching changes in the *personnel* of the Department of Revenue and Agriculture. In Sir Claude Hill the department was losing a head who had ever identified himself absolutely with the interests of the Service, and in Mr. Mant they had always had a sympathetic and helpful Secretary.

On the conclusion of the President's speech, committees were appointed to deal with the various subjects. It is not possible within the limits of a brief article to do adequate justice to the interesting debates and the important resolutions resulting from these discussions. This information will be found in detail in the published proceedings of the Board.

The first two subjects were considered together at a full meeting of the Board and dealt with the danger of the depletion of the nitrogen content in Indian soils by the introduction of high-yielding varieties of crops and intensive cultivation, and the resulting importance of investigations into the conditions of nitrogen fixation in Indian soils. Mr. Hutchinson, who opened the discussion, compared the depletion of the nitrogen reserves in Indian soils to the exhaustion of European coal-fields. In Bihar the cultivator deliberately avoided securing a higher yield by intensive cultivation and aimed at a low average yield which would not deplete the fertility of the soil. The level of this fertility was determined, partly at any rate, by the natural rate of nitrogen fixation, and he would urge upon the Board the desirability of passing a resolution on the necessity of research upon nitrogen fixation in Indian soils. Mr. Burt, while in sympathy with the suggestion for research on nitrogen fixation, thought that there was little evidence of soil exhaustion in the districts with which he was familiar. It was of great importance that improved cultivation and manure should accompany the introduction of improved varieties. The Board finally passed a resolution stating that the time had now come when every province should have its own Agricultural Bacteriologist and that the staff of the Imperial Agricultural Bacteriologist should be strengthened.

The Board then considered the report of the committee on subject (iii), dealing with the export of cattle abroad. The committee stated that they did not consider that any deterioration, to a marked degree, was taking place in Indian cattle or that any such deterioration could be due to export abroad, as this was a negligible feature of the total export. The report was accepted by the Board.

The debate on subject (iv), dealing with agricultural forecasts and statistics, was of great interest. Mr. Noyce, in moving that the report of the committee on this subject be adopted, said that while the figures for crop areas in India were among the most accurate of their kind, the estimates for normal yield and the condition factor were naturally less easily made. Crop-cutting experiments should be used as a check and not as a basis for arriving at the normal yield. He hoped that the time was not far distant when every province would have its own statistical department.

Dr. Gilbert Slater said that he had endeavoured during the sittings of the committee to get a clear idea of the duties which would be imposed on Directors of Agriculture by the adoption of the committee's report. The first duty of each Director would be to secure the appointment in his office of a special assistant for statistical work. Each Director of Agriculture would become engaged in a deadly conflict with a gentleman whom he would call "Mr. X". "Mr. X" is the official who is hidden in the recesses of the Finance Department of the Secretariat of each Government in India, who shroffs all proposals of executive departments before they reach the Hon'ble Member, and who devotes his great industry and persistence to the task of invariably spoiling the ship to save a ha'porth of tar in the name of economy. He knew quite well what was in store for the Director of Agriculture when he endeavoured to act in accordance with the resolutions of the Board. He will ask for a statistical officer, "Mr. X" will at best be willing to concede a clerk on Rs. 25 per mensem. He will ask for a soil bacteriologist, "Mr. X" will try to limit the salary to Rs. 15. For he regards himself as the faithful defender of the poor tax-payer from the wild onslaughts of Directors of Industries and Directors of Agriculture. The whole future of Indian agriculture depended on the winning of victories by the Agricultural Departments over these elusive and anonymous opponents. Members might remember that in England the master stroke of Edwin Chadwick, in his great campaign for public health, was securing in 1837 the complete registration of births and deaths. That was what supplied the lever by which the necessary financial provision was secured for one

measure after another for combating death and disease. Similarly, reliable agricultural statistics would furnish the lever for securing what is financially necessary for agricultural progress and prosperity for India.

Mr. Jacob then explained to the Board how aëroplanes had been used for taking photographs to form a crop survey in Lahore, and the Board passed a resolution that further investigations in the application of aeroplane photography to crop surveys should be carried out.

Mr. Wood said that he considered that the committee had over-emphasized the importance of crop-cutting experiments. Crop-cutting experiments to be of any use must be so numerous as practically to prevent them being carried out by the staff available. He moved that the Board pass a resolution that crop-cutting experiments should be abandoned. This was not carried and the report of the committee, with slight amendments, was adopted by the Board.

The next subject (v) before the Board was whether any special measures are necessary with regard to the introduction of motor ploughs and tractors. In reading the report of the committee on this subject, Mr. McSwiney urged the appointment of a Government Tractor Engineer to safeguard the interests of the buyers, who might otherwise be sold unsuitable machinery by agents who have no knowledge of agriculture. On the motion of the President a resolution was carried to the effect that a section of Agricultural Engineering should be established at Pusa to investigate the use of agricultural power machinery, with special reference to motor ploughs and tractors. The report of the committee was then accepted by the Board.

From this the Board passed on to a consideration of what steps might be taken to encourage the manufacture of improved tillage implements (subject vi). Dr. Coleman, in moving the adoption of the report of the committee, said that research work on this subject was a function of the Agricultural Department, and urged that Agricultural Engineers should be recruited to the Indian Agricultural Service especially for this work. Other speakers suggested that the matter might be left to the enterprise of private firms, but the

sense of the Board was finally expressed in a resolution stating that research work on the lines indicated in the report of the committee was a function of the Agricultural Department, and that Agricultural Engineers should be appointed to the Indian Agricultural Service for this purpose. The Board laid special emphasis on the fact that such engineers must be members of the Indian Agricultural Service and not attached to the Department of Industries.

Sir Claude Hill then addressed the Board as he had to leave Pusa that day. He said that this was, to his great regret, the last occasion on which he would address the Board as Member for Revenue and Agriculture. The Board was to be congratulated on the work which had been got through up to date. He was particularly glad that the Board had passed the resolution on the establishment of an Engineering Section at Pusa and had endorsed the desirability of extending bacteriological work. The Hon'ble Member then dealt with the difficulties which had attended agricultural progress during his years of office. The incidence of war and famine had magnified the tasks of the Agricultural Department and handicapped that development and progress which they all had at heart. Still the previous five years had not been barren, and thanks to the loyal and able support which he had received from all ranks of the various departments of agriculture, much had been achieved. Agricultural education and the problems of cotton and sugar had all been the subject of special enquiries. With regard to the former a stimulus had been given which promised in the near future to revolutionize the older methods of agricultural education, while the success of the Cotton Committee, over which Mr. Mackenna had presided so ably, was evidenced by the appreciation of its report at the hands of the public and the Empire Cotton Growing Association. As they all knew, they were now confronted with far-reaching political changes, but he looked with confidence to the future and the part which the Indian Agricultural Service would play in it.

The Board then proceeded to the discussion of subject (vii), whether the Agricultural Department should undertake the writing

of school readers and story books. Mr. Clouston moved that the report of the committee should be accepted. He thought that in this way much might be done to make the aims and successes of the Agricultural Department more fully appreciated by the people. Dr. Kunjan Pillai and Mr. Dutt both supported Mr. Clouston, and urged that more attention be given to the production of popular bulletins. Dr. Coleman said that the subject of getting in touch with cultivators had been debated *ad nauseam* in the Board for years. It was not a testimony to the intelligence of the Board to ask them to accept this report and he moved its rejection. After some discussion the report of the committee was rejected by the Board but a resolution to the effect that officers of the Agricultural Department, who felt qualified to do so, might attempt literature of the type under discussion was accepted.

The question of allowing village *panchayets* to raise local rates with a view to maintaining roads, drainage and irrigation works (subject viii) was then considered. Mr. Dutt, I.C.S., in moving the adoption of the report of the committee on this subject, explained the advances which had been made on these lines in Western Bengal where the maintenance of irrigation tanks was of great importance and could only be satisfactorily achieved by some system of local co-operation. The report of the committee was accepted by the Board which then passed on to a consideration of the practical methods which might be adopted for the conservation of natural sources of manure, such as bones and oil-cakes, for use in the country (subject ix).

Mr. Wood read the report of the committee and placed four resolutions before the Board. This initiated one of the most interesting of the discussions of the meeting. The question of the advisability of placing an export tax on oil-seeds and cakes showed a sharp division of economic thought among the speakers but was finally agreed upon. A large majority of speakers emphasized the fact that the export of bones and fish manures was a drain on the fertility of the country and the Board finally accepted a resolution that total prohibition of export was necessary. The committee's proposal that a portion of the revenue derived from the

export tax should be earmarked for propaganda work on manures was withdrawn, as the Hon'ble Mr. Mant explained that the proceeds of Customs duties were an Imperial asset and agricultural propaganda under the Reform Scheme would be a charge on Provincial revenue; obviously Imperial funds could not be earmarked for Provincial expenditure. The Board finally passed a resolution expressing the hope that Local Governments would consider the claims of their Agricultural Departments to increased allotments for propaganda work.

The Board then considered the report of the committee appointed to deal with the duties of the Agricultural Departments under famine conditions and the manner in which the Agricultural Department should prepare to face famine (subject x). The extremely able report of this committee was very lengthy and its adoption was moved by Dr. Mann. The Board accepted, with slight amendments, all the proposals of the committee with reference to well-boring, the surveying of rivers and the erection of embankments to check erosion. Other measures approved by the Board were the transport of cattle by rail from famine tracts to better provisioned districts, investigations into grain storage on a large scale and the collection of statistical information with regard to the main food crops. In the discussion on these matters perhaps the most interesting fact which emerged was the opinion expressed by Dr. Slater that the success of recent famine relief measures had resulted in smaller stocks of grain being held in the country. If grain was not in the country, money was useless. Had, as seemed possible at one time, the 1919 monsoon failed, this situation would have arisen and the problem would have been an international one. The Board recommended the appointment of a strong Famine Commission to consider the problems which would arise by the failure of two successive monsoons. The fact that the duties of the Agricultural Departments under famine conditions had not been clearly defined was also the subject of a resolution.

The report of the committee appointed to review the results of the permanent experimental plots at Pusa and to make proposals for this line of work in the future (subject xi) then came before the

Board. In their report the committee drew attention to the facts that the multifarious duties of the Imperial Agriculturist, and the frequent changes of tenure in that office, had prevented that continuity of supervision which was so essential in field experiments, and the committee therefore recommended the appointment of an Imperial Agronomist, who would supervise the experimental area, to the staff at Pusa. The recommendation of the committee was accepted by the Board.

Lastly, the Board considered the improvement of cotton marketing in India with special reference to the Indian Cotton Committee's Report, paragraph 233 (subject xii). The Board had the advantage at this sitting of the presence of Messrs. Cocolas and Wait, representing the cotton trade. The committee on this subject recommended the establishment, with certain modifications, of markets on the Berar system. The dangers attending co-operative sale societies with a crop the price of which fluctuates as much as that of cotton were felt by the committee to be very great and the committee for this reason rejected recommendation (4), paragraph 233, of the Indian Cotton Committee's Report. On the motion of Mr. Noyce, the Board recommended that the sectional meeting of cotton workers proposed by the committee should take place in Bombay in conjunction with the first meeting of the proposed Central Cotton Committee.

On the conclusion of the formal business before the Board, Dr. Butler addressed the meeting and expressed the regret felt by all members of the Agricultural Departments that they would not again meet under the chairmanship of Mr. Mackenna. Dr. Mann supported Dr. Butler and said that in Mr. Mackenna the Department of Agriculture had always possessed a chief who was in complete sympathy with the work and hopes of all its members. The agreement of the Board with the sentiments expressed by the last two speakers was indicated by the prolonged cheers which greeted Mr. Mackenna when he rose to reply.

Mr. Mackenna said that of all the speeches he had made at the Board of Agriculture this was for him the most difficult and trying. While he could not definitely say that he would be leaving

India for good, he thought it improbable that he would again preside at a meeting of the Board of Agriculture in India, and he felt very much leaving a department with which he had been connected for so long and in which he had made so many intimate personal friends. In point of fact, he would never have accepted the Agricultural Advisership had it not been that he knew that he was personally acceptable to the department and that every member of it would give him every assistance he could to make the tenure of his appointment a success. He had received the most loyal support from every member of the department, and any success which had been achieved was due to them and not to him. As agricultural officers they had a great responsibility. The future of India lay in the development of its agriculture and of its industries, and if these prospered, we would have a happy and contented people. The future of the agriculture of India lay in the hands of those whom he was now addressing, and in wishing them an official good-bye he felt that he was leaving that future in safe hands. He wished them all every success in their careers and would only add that he bade them an official farewell with the deepest personal regret.

This terminated the eleventh meeting of the Board of Agriculture, which, it may confidently be said, will rank as one of the most successful, both from the point of view of work and social recreation, ever held in Pusa. All those members and visitors who were new to the Agricultural Research Institute and Farm took advantage of their visit to inspect the resources and equipment of the laboratories and estate, and the opinion was generally expressed that it would be an advantage if, at future meetings at Pusa, more time could be made available for this purpose.

THE MOTOR TRACTOR IN AGRICULTURE.

SOME IMPRESSIONS OF THE TRACTOR TRIALS HELD AT LINCOLN IN SEPTEMBER 1919.

BY

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DURING the last week of September 1919, a great event in the history of agriculture took place at Lincoln. This was the tractor trials organized by the Society of Motor Manufacturers and Traders with the aid of the National Farmers' Union. To find a parallel in its significance to British agriculture one must go back, in the opinion of the writer, to the substitution of horses for oxen or iron for wood. There seems little doubt that the internal combustion engine will, sooner or later, take the foremost place, as a prime mover, in agricultural work both on the land and in the homestead—a position which the steam engine never attained. The paramount necessity for increasing the food supply of the people during the great war was, of course, the immediate cause of bringing the tractor to the front, in Europe at any rate. At first the demand for tractors was met by imports from America, but British firms soon turned their attention to tractor design and construction with the result that wonderful progress has been made during the last two or three years in perfecting this machine. Already large numbers of tractors have been quietly absorbed into British farming, but it required some such exhibition as that held at Lincoln to focus general attention upon this great, new force in agriculture and to mark its initiation into the stock-in-trade of the farmer. It is true that some tractor trials were held in Scotland two years ago, but these appear to have been somewhat

premature, at any rate as regards British makes. The importance which the tractor has suddenly assumed can be gauged from the fact that upwards of forty different makes were exhibited at Lincoln; most of which were demonstrated on the land. These included every tractor of importance that is on the British market, including a large number of American makes and one Italian machine. The exhibition extended over a week but the first two days were reserved for the judges. The ploughing trials extended over three days, during which time some five hundred acres of stubble and lea were ploughed up: there were also threshing and hauling tests, while one afternoon was devoted to secondary operations on the land such as harrowing. These trials took place in some twenty-six fields spread over several square miles, and visitors from all parts of the country were present in large numbers.

The object of the Lincoln trials was not to convince the farmer of the utility of the tractor—that was assumed—but to assist him in the selection of the tractor best suited to his particular farm and needs. The National Farmers' Union appointed six eminent gentlemen—members of the Council of the Union and all successful practical farmers—to judge the trials, and they were assisted in technical engineering matters by a prominent consulting engineer who specializes in tractor design. These gentlemen will issue a full official report upon the trials, and it is not intended in this note to anticipate that report but merely to record some impressions of the writer who was fortunate in being present on three days.

A few general facts and figures may, however, be mentioned to indicate the broad features of the tractors. First, as regards power, the machines varied from 20 to 40 h.p., but the majority were below 30 h.p.; the four-cylinder engine predominated and the fuel used in the majority of machines was petrol or benzol, but some paraffin machines were shown. Machines were fitted with two to three forward speeds (in one case nine) and one reverse; the forward speeds ranged from two to five miles per hour. The lightest tractor present weighed about one and a quarter tons (ready for work on land) and the heaviest about five tons. The

four-wheeled machines predominated, but there were a few three-wheeled machines, and there were three or four caterpillar machines; there were also a few self-contained motor ploughs. The enclosed spur wheel and worm wheel were the common forms of drive, but there were a few chain-driven machines. Prices ranged from £280 to £650. The plough associated with these tractors was the two to three-furrow self-lift type, costing from £40 to £60. Cultivators and harrows had a spread of seven to eight feet. In the majority of cases when ploughing, only one attendant was required; this man sat on the tractor and operated the ploughs by means of levers—a trip arrangement causing the ploughs to enter or leave the land.

Impressions.

1. The first impression to record is that the tractor has come to stay, and will play a part in the field comparable to that played by the motor car on the road.

2. The excellent performance of the tractors, taken as a whole, was remarkable; it was the exception to see a machine in difficulties: practically all appeared to be well above the work they were called upon to perform.

3. The speed at which the work was done was an impressive feature. This exceeded five miles per hour in some cases, whereas horses travel at less than half that rate. This speed was well maintained in secondary operations over soft, loose soil.

4. The space allotted for turning was considerable, perhaps 25 feet, but the smaller tractors did not require so much room—they were, in fact, shorter than horses, and could probably be turned in less space and with greater ease than a pair of horses.

5. The small tractors in particular appeared to be very easy to manœuvre, and would go anywhere.

6. For secondary operations, such as harrowing, the light tractors appeared to hold a distinct advantage as the wheel tracks left by the heavier machines could be seen in well-defined depressions, but both types were quite capable of crossing soft soil without getting their wheels buried; this was due to the width of the wheel and the well-designed wheel attachments.

7. The tractors were well designed in point of steadiness over rough or uneven ground, showing no tendency to upset when one wheel became raised many inches above the other.

8. The wheel machines seemed to appeal more strongly to the spectators than did the caterpillar types, as the moving parts of the latter appeared to be too numerous and too congested, and, therefore, likely to suffer severely in wear and tear and to get out of adjustment readily. At the same time, the writer was very much impressed with the behaviour of one of these caterpillar machines; it moved rapidly, turned quickly in a small space and appeared to be particularly well balanced (longitudinally), which character enabled it to draw a disc-harrow over ploughed land in a very attractive manner, passing over furrows with ease and rising to ridges as a boat breasts waves. The self-contained motor plough did not impress one favourably, as it appeared too complicated.

9. The tractor, with its relatively great speed, its power to draw gang ploughs and its capacity to work long hours, must be invaluable in periods of great pressure when, for example, a favourable opportunity for sowing may last a day or two and not recur for weeks.

10. In view of the large number of tractors on the market it is obvious that design has not yet reached finality; it is highly probable that numbers will disappear and that those that survive will be modified and reduced to a few more or less uniform types; as regards the best makes, these changes will not, perhaps, be fundamental but only in the direction of greater efficiency, but the adoption of liquid fuel will probably come in time.

The lesson for India.

As stated in the preceding paragraph, the last thing in tractors is not yet on the market, but there are already machines of great efficiency. The tractor is even now a rival of the horse and will be the main factor in maintaining a high area of tillage in British farming. In India there is undoubtedly scope for the tractor, but before it can be taken up on a practical scale it will be necessary for the Agricultural Department to solve certain preliminary problems.

These are: (1) to carry out exhaustive trials with a number of selected existing makes in order to ascertain the most suitable machines for different conditions, and (2) to devise some scheme whereby a class of competent tractor drivers can be evolved. The Lincoln trials were not sufficiently severe from an Indian point of view. At Lincoln the soil was in ideal condition, possessing just the right amount of moisture so that the ploughs cut through it as a knife passes through butter. It is quite possible that some of the tractors which did well at Lincoln would fail under Indian conditions. There is, moreover, a much greater range of conditions in India than in England. It is necessary to ascertain the best tractors, on the one hand, to work in the dry season on heavy black cotton soil, and, on the other hand, to work in association with irrigation in the Indo-Gangetic plain, to mention only two conditions. Such trials must obviously precede useful suggestions for modifications in design to suit particular Indian conditions.

It has been the common experience of all agricultural officers concerned with district work in India that the greatest impediment in the way of improved tillage was the weak condition of the cattle; this is always the stumbling block when improved methods are attempted. The tractor points to a solution of this difficulty, though the scale of application may be limited for many years.

There seemed to be two circumstances in which the tractor would prove of especial value in India: (1) to assist a devastated famine tract, where the cattle have died, to recover rapidly and at the first opportunity, *e.g.*, tractors equipped with grubbers and drilling machines would enable large areas to be promptly sown with some cereal such as *bajri* (*Pennisetum typhoideum*); and (2) to enable tracts opened up by new canals to be rapidly developed: it is usual when a new canal is opened for several years to pass by before the existing population can adjust its resources and organization to the new conditions. More cattle have to be found and more labour obtained. Even where colonists are imported, it takes several years to develop the tract.

These considerations bring home the fact that the Agricultural Department could hardly perform a more useful function than thoroughly to investigate the possibility of the tractor in India. The great fault with agriculture in this country is the low yield per unit of area, and this is due, in very large measure, to the low standard of tillage farming: the land is seldom clean and the soil not sufficiently worked in many areas. If these defects could be removed, the first step would be taken towards an improved level of yields, and other steps, such as providing an adequate manure supply, would be simplified. A lakh or two of rupees expended upon this problem would be money well invested.

NOTES ON THE PROGRESS OF THE EUROPEAN OLIVE AT PESHAWAR.

BY

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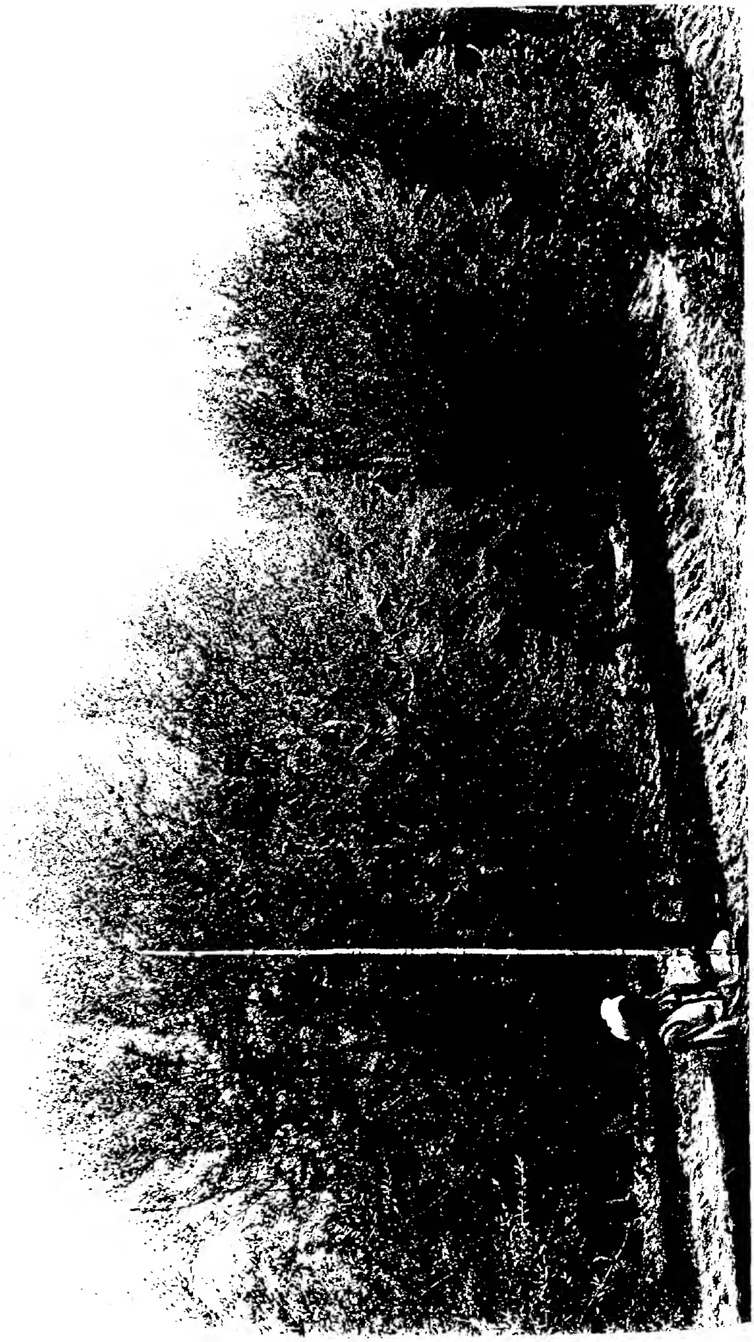
AFTER many years of almost unrestricted grazing and felling, the wild olive (*Olea cuspidata*) is still common on the Himalayan foot-hills, and slopes abound on the North-West Frontier that would soon be clad with the tree if a period of protection were given. Cherat is a good example of a protected tree-clad hill. As the crow flies, it is situated about 15 miles from the Peshawar Agricultural Station, and it rises, a mass of rocks, to a height of about 4,000 feet. Outwardly it appears destitute of soil, yet, in striking contrast to the bare hills around, its steep sides are densely covered with coppiced olives, almost to the exclusion of any other tree. Along its crest, contingents of the Peshawar Brigade in turn wearily spend the long summer days. Cherat hill is cool and tolerable in the evening only : by day it is made green and habitable by the olives that shelter the bungalows and the winding hill paths.

And each succeeding year, it would appear, the idea occurs to some marooned officer, as he walks forth after sundown, that the olive of commerce would surely be successful where the wild olive grows so well. Almost every year the suggestion is made by someone to the Agricultural Department that the European olive should be introduced to the North-West Frontier hills. The same thought occurred to the writer as he viewed Cherat in 1910, and in the spring of the following year 100 European olive plants were imported from Naples for trial at Tarnab. The plants arrived in excellent condition. The season, was, however, too far advanced to get the trees established before the burning hot June days set in. They were therefore planted at 15 feet apart that



they might be closely observed and, if necessary, protected. The intention was to transplant two-thirds of the trees in the following spring. But for several reasons, chief among which was the fear that the plants might not transplant successfully, they were allowed to remain as they were—to provide nursery stock. But they grew so vigorously that they threatened to form a thicket which would neither yield propagating wood nor fruit (Plate VIII). It was, therefore, decided to carry out the original idea—to move two-thirds of the trees. This work was started in 1918, when the trees were nearly seven years of age and after most of them had borne from 5 to 20 pounds of fruit.

They were transplanted without soil balls, but were most carefully dug out and set in their new positions. The root-spread

Heads of transplanted olive tree cut back.

of each tree was restricted to 6 feet diameter, and it may be mentioned that, contrary to expectations, all the root systems were extraordinarily shallow. The roots were almost as abundant as fibrous and close to the surface as those of healthy peach trees. No tree had a tap-root. No doubt this was due in a measure to the irrigation which the grove received. The heads of the transplanted trees were cut back in a manner which is very well shown in the figure above. After the soil was settled about the roots by liberal flooding the trunks and branches were wrapped in dry sugarcane leaves to protect them from the sun and, possibly, from frost. Most of the trees were transplanted in January and February, and soon it was apparent that those that were moved first grew more vigorously than those that were transplanted later. By the end of March the branches bristled with plump green buds, which quickly extended and became vigorous limbs. Now, a year later, the olives have big healthy green heads. The trees promise to catch up those that were not transplanted. *It has been determined that established olive trees, full seven years of age, 15 feet in height with 12 feet spread, can be safely transplanted without soil balls.*

Regarding the potentialities of trade in olive products in the North-West Frontier, thus far the trial at Tarnab has shown that the foreign species grows and bears well and early under irrigation, despite the very high temperature and scanty rainfall. At five years of age several of the Tarnab trees yielded up to 20 pounds of plump, well-developed olives, and now, at eight years of age, many of the trees are bearing from 100 to 120 pounds of good fruit.

The percentage of oil from young trees is said to be low, and analyses of the Tarnab fruits proved that they were not exceptional.

There is one ominous danger that clouds the prospects of a trade in olive products on the North-West Frontier hills. In 1916 it was discovered that a destructive olive fruitfly (*Dacus oleæ*) is abundantly present in Himalayan olives. The pest may be expected to attack European olives if they are established on the Frontier. The story of the discovery of the fly is interesting and it may be told. An Italian entomologist desired to know if the

Himalayan olive was attacked by the olive fruitfly that is so well known in Europe and, if so, whether the fly had a parasite. The hope of the scientist was that a parasite might be found in India which could be introduced to combat the olive fly in Italy. Accompanied by the writer, the Imperial Entomologist visited the Cherat hill in 1916 to search for the fly and, perchance, to find its parasite. Almost before baggage was unpacked, the Imperial Entomologist found an olive which contained a maggot suspiciously like that of a small fruitfly. A quantity of wild olives was collected and conveyed to Tarnab. There, before many days passed, a large number of fruitflies emerged from the olives. Happily, many olive fruitfly parasites simultaneously came forth. *The high hope that India might grow olives unchecked by the fly was cast down.* But a cheerful wit has said: "I have had many troubles most of which never came off." Perhaps the fly which afflicts the Himalayan olive will not prove destructive to the European one. Or the olive fruitfly parasite on the Himalayas may be a vigorous one well able to control the olive fly. At the worst, there remains the assurance that this pest on olives is in a measure controlled in Europe by pruning and careful cultivation. Now that the Tarnab trees have attained bearing age, hopes and fears regarding the fly and its parasite should soon be set at rest.

During the progress of the olives at Tarnab it was observed that some sour oranges near the grove were constantly yellow and unhealthy, whilst oranges slightly more distant from the olives were dark green and vigorous. It appears that the orange cannot be successfully interplanted with the olive. This is somewhat of a disappointment at Tarnab where it was intended to try this combination, because, wherever the orange is grown in North-West India, many fruits on the south-west side of the trees are "sun scorched" and spoiled. It was hoped that the olive, whilst yielding a profitable crop, might protect the orange fruits from the sun.

This autumn one or more of the Tarnab olives, which are now fruiting so well, will be selected for propagation and distribution to the hills. But a number of years must elapse before olive oil from the Afghan hills is on the market.

THE DEVELOPMENT OF CANE PLANTING BY THE EAST INDIA DISTILLERIES AND SUGAR FACTORIES, LTD.

BY

MESSRS. PARRY & CO.

(*Managing Agents.*)

THE East India Distilleries and Sugar Factories, Ltd., may be said to be the pioneers of the cane sugar industry in the Madras Presidency and some brief account of their progress and experience is worthy of record, explaining as it does some of the reasons why central cane factories in India are not always successful, and showing in a general way some of the difficulties to be expected when cultivating cane on a large scale.

A successful cane sugar industry requires large tracts of land within easy reach of a central factory, it being of first importance that cane once cut should pass through the mills within 24 hours of harvesting.

The first problem therefore was to procure suitable lands adjacent to the Nellikuppam Factory and, following on that, sufficient labour to cultivate them.

Here was presented an initial difficulty which at one time seemed insurmountable. For many years the local ryots had grown cane which they brought to the factory to be crushed; but this could never be relied upon as a regular source of supply for the reason that cane was only cultivated when it suited the ryot, *i.e.*, when the price of paddy and other crops offered less inducement than the price which the company could afford to pay for cane.

It was felt that development must lie in the direction of cane farms belonging to the company, but this was apparently an impossible proposition in view of the very high rents required for what are known as "wet" lands upon which only, it was believed, cane could be satisfactorily cultivated.

The very low price of sugar on account of cheap imports from Java and elsewhere made rigid economy a necessity, whilst the question of obtaining sufficient labour to cultivate the land was a further obstacle.

The introduction of the oil-engine for pumping purposes was the beginning of a new era, suggesting as it did the possibility of irrigating the large tracts of "dry" lands in the neighbourhood of the factory which had hitherto proved a comparatively poor source of income to the landowners. In the course of several years' experiments, certain tracts of these "dry" lands were found suitable for the cultivation of cane, and the company commenced to negotiate for leases with a view to expansion to the extent of the labour available.

Such negotiations were at first lengthy and arduous, but some 40 acres were eventually planted, and the problem of procuring a variety of cane suited to the extremely trying Indian climate next presented itself.

It was necessary to find a cane capable of withstanding the hot weather and dry winds of May and June, and equally capable of developing sufficient strength to stand up against the heavy downfall of rain generally experienced between October and December.

With the assistance of the Government Cane Breeding Station at Coimbatore many varieties were experimented with and it was eventually found that the Ashy and Red Mauritius canes would grow more or less satisfactorily, though the yield in tons per acre left very much to be desired in comparison with the crops grown in other countries.

It will thus be seen how handicapped the company was at the start. Land was difficult to obtain, labour at the time of cultivation comparatively non-existent, and suitable canes had to be discovered, the growth of which owing to climatic conditions was only about half

the tonnage per acre accepted as necessary for economical development on a commercial scale.

However, having satisfied themselves that by patient negotiation land was procurable, the company's attention next turned to the question of seasoned canes, irrigation and artificial manuring. The sinking of wells and establishment of pumping stations were easy matters; and judicious manuring demonstrated that reasonably satisfactory crops could be produced if experienced attention was given to the selection of seedlings.

To arrive at this point required much patient investigation, and having surmounted to a great extent the initial difficulties the labour problem had to be considered.

There is plenty of labour to be obtained in the district but as the preparation of land must take place simultaneously with the harvesting of the groundnut crop—more easy and congenial work—some method of mechanical cultivation was essential. To deal mechanically with small plots of "wet" land surrounded with bunds and irrigation channels was not practicable, but having proved that cane could be grown on the large tracts of "dry" land, a Fowler's double engine steam tackle was purchased for ploughing, trenching and cultivating (Plate IX).

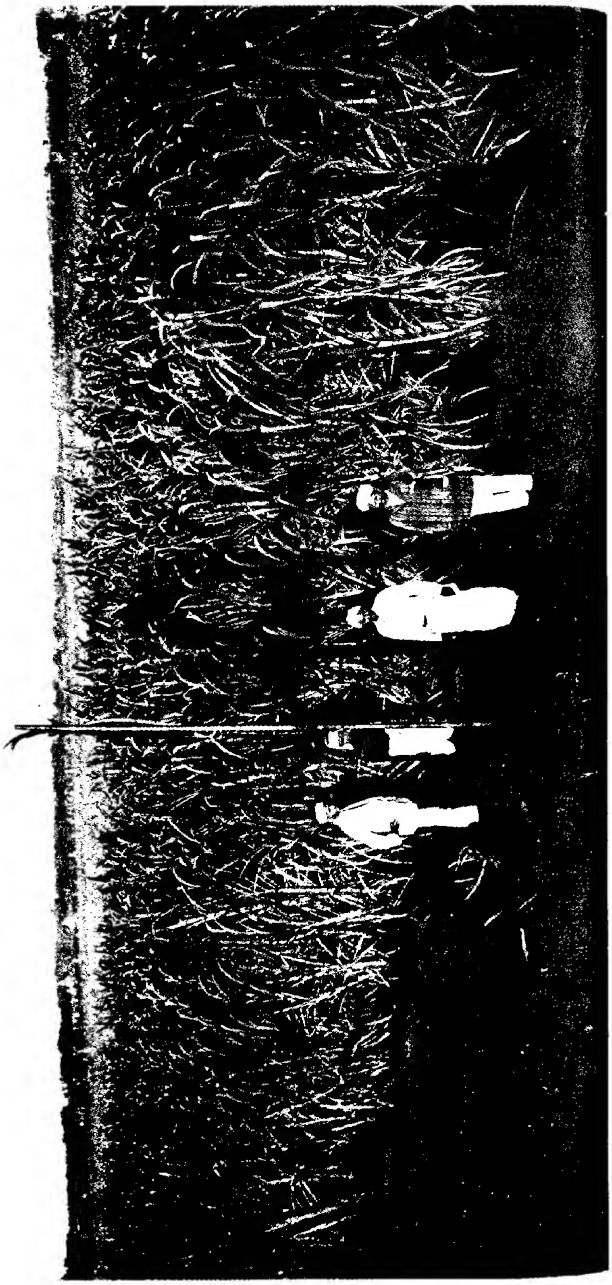
This after a year's experience proved a decided success, doing better, quicker and cheaper work on a large scale than had formerly been possible by hand labour even on a very small scale under constant and thorough supervision.

The company was now in a position to go ahead with development and commenced to extend their operations to the limit of their powers of mechanical cultivation, *i.e.*, 7/800 acres.

With this extension the improvement and capacity of the factory mills became essential, and the general activity shown in all directions brought the ryots to realize that the cultivation of cane for the central factory was a steady source of income worthy of attention.

Encouragement to extend the acreage planted by ryots was given in the shape of advances and seedlings, whilst much was done to assist them by the sale of oil-engines and pumps on easy payment

STEAM PLOUGH AT WORK ON DRY LAND



terms. As a result, the acreage under cane extended very nearly to the limit of the factory's capacity and the question of transport at harvest time became a problem.

Carts had hitherto been obtainable for the company's crops but were now to a great extent requisitioned by the ryots themselves. In addition, it was found that to convey loaded carts of cane across trenched fields to the roads was a tedious business and heart-breaking to cattle. The company therefore laid down a light portable tramway across their larger farms, with trucks which could be easily propelled by hand labour. This tramway brings the cane to a point on the main road where bandies can be loaded for a comparatively short journey to the factory, and it is intended later to carry the line up to the South Indian Railway and despatch the cane on special trains, thus releasing more carts for work in other directions.

During all the above operations the company was endeavouring to secure a cane of better class than the Red Mauritius variety which, while appearing to be immune from any serious disease, is not of a very high sugar content.

The following table gives particulars of various canes experimented with, and it will be noticed that the most promising of all is Fiji B:—

Name of varieties	*% Brix*	*Purity*	*Tons of cane per acre*
Fiji B.	16·76	83·01	47·78
Kallakurichi	12·46	56·80	42·85
Big Tanna	15·97	78·89	40·96
D. 131	15·77	77·43	37·94
Purple Mauritius	15·50	79·49	37·55
131	14·72	70·28	37·51
Ashy Mauritius	16·71	84·55	36·64
55	15·18	75·72	36·07
B. 3412	17·08	79·77	34·31
D. 74	14·86	77·05	34·01
B. 147	16·01	81·27	32·00
D. 625	15·45	75·41	28·40
Ashy Mauritius	16·78	82·88	25·89
Red Mauritius	16·98	79·57	22·97
Java 247	14·46	76·54	22·60
Ashy Mauritius	15·31	76·35	20·86
Java 247	14·70	73·28	20·24

It must, however, be recollected that the very good results shown have been obtained on specially selected experimental plots,

and that on an average nothing like the tonnage indicated can as yet be expected.

Up to date the average figure has been about 25 tons per acre but by careful manuring it is hoped to bring the figure to 30 tons, which is probably the limit to be obtained in the Madras climate.

This figure is naturally dependent on the rainfall, and the crops harvested in 1919 owing to continued drought during the preceding year were very much below the tonnage hitherto experienced. As a result, the planting by ryots this year has shown a considerable falling off and the company therefore now proposes to make arrangements to increase its own farm acreage to make itself less dependent than hitherto on supplies from outside sources.

We give below some notes supplied by the Manager of the Nellikuppam Factory which are of interest :—

"I am of the opinion that cane Fiji B, a few sets of which we got from Coimbatore about 4 or 5 years ago, and the area of which we have gradually extended, is likely to prove a much more useful cane than Red Mauritius. It is a short, thick cane of very erect growth and not liable to be blown over by high winds. It has a comparatively high sugar content and crushes splendidly in the mills. The rind is sufficiently hard to defend it from jackal attacks, and during the four or five years we have grown it, although it has been tried under all sorts of varied conditions, it has shown no signs of disease but on the contrary has distinctly improved in appearance and growth. I think the fact that the local ryots have taken spontaneously to this cane as they never did to any other variety, argues well for its popularity and success in the future.

"With the irrigation facilities we have, our canes generally start very well indeed and give a good and regular stand and very few blanks have to be filled up, although we maintain small nurseries for this purpose. I have shown our young plantations about a month or two old to experienced planters from Mauritius and they seem to think that our canes make a much better and quicker start than they do in that island. Unfortunately, on occasions we have long spells of very dry weather accompanied by hot winds. During such times, even with ample well irrigation, the cane does

not appear to grow at all, and I consider this climatic difficulty is a very serious one and accounts to a great extent for the lower yields obtained in India than in countries favoured with a more humid climate. Further, we have a period in November and December of excessively heavy rain, amounting sometimes to 35 inches in a month, which also does damage to the crop by laying it. The juice of such cane has always a very low purity but no practical means has been found of obviating this difficulty. The introduction of a shorter and thicker cane is the only way we see out of it."

DEVELOPMENT OF IRRIGATION FROM BHIND CANAL: A PLEA FOR ECONOMICAL USE OF WATER.

BY

S. K. GURTU, M.A., M.I.C.E.,

Member, Board of Revenue, for Irrigation, Gwalior State.

In reviewing the proposals for the Bhind Canal, Gwalior, in 1910, Mr. Preston, after going into detailed calculations in regard to storage and loss in reservoirs and canals, arrived at a net volume of 2,697 million cubic feet on the fields, and assuming the total depth of watering a little over 12″ (which meant three to four waterings on the fields) estimated irrigating 110,000 *bighas*. He also considered the possibility of irrigating 200,000 *bighas* with 18″ watering in good years. These were theoretical figures estimated before the development of the canal began.

Since 1910, there have been several changes in the lakes. The maximum and average storages of the four lakes now are 10,400 and 6,100 million cubic feet, respectively. These will be subjected to three deductions to get the net volume on the fields:—

1. Evaporation and absorption.
2. Loss in river bed in transit.
3. Loss in canal bed in transit.

After deducting the losses, the net quantities on the fields under maximum and average conditions are 6,010 and 3,040 million cubic feet, respectively.

Originally it was assumed that there would be no loss in the bed of the rivers by water travelling from Tigra and Pagara to Kotwal and Pillowa pick-up weirs, but it has several times been observed that a discharge of 500 cusecs from the higher lakes has

only given a discharge of 400 cusecs at the canal off-take. The loss in the river channels has therefore been assumed to be 20 per cent.

According to the duty which is assumed in projects for net storages, the maximum and average quantities would suffice to irrigate $6{,}010 \times 30 = 180{,}300$ *bighas* and $3{,}040 \times 30 = 91{,}200$ *bighas*, respectively. These figures are about the same as assumed by Mr. Preston.

The development of the Bhind Canal began in the winter of 1914; we have had five irrigation seasons. It will not be devoid of interest to examine the duties obtained in these years.

1. Irrigation season of 1914-15.

In the first year most of the canals were unfinished and beds not properly cleared. We irrigated an area of about 25,000 *bighas*. No records were, I regret, kept about the storage, etc.

2. Irrigation season of 1915-16.

During this year the net volume on the fields was 2,120 million cubic feet, whereas the irrigated area was 70,000 *bighas*. The crops irrigated were gram and wheat in the proportion roughly of 1 to 3, and the number of waterings varied in different portions of the irrigated tract. In the Tehsils near the head-works, from three to four waterings were given, including the first "paleo" watering (*i.e.*, watering necessary to moisten the fields for sowing). In the tail portion, the number varied from one to two. The total area was, however, small. The average duty* obtained in this year was 33 *bighas* per million cubic feet.

3. Irrigation season of 1916-17.

In this year the rainfall was abnormal. Indeed it beat the record. There was little demand for irrigation. The total irrigated area was 37,400 *bighas*, against the utilized quantity of 1,200 million

* In hydraulic engineering duty means the area which a given quantity of water can irrigate in a season or a year.

cubic feet. This gives a duty of 31 *bighas* per million cubic feet. The loss in the water-courses in this and in the previous year was rather high, as it was not considered expedient, in introducing irrigation in a tract where it was unknown before, to insist on a proper construction and maintenance of water-courses, as that would have scared the irrigators. With better water-courses and stricter supervision, the duty is increasing.

4. Irrigation season of 1917-18.

This year also was a wet year. The Sank-Asan system suffered a grievous loss in the failure of the Tigra dam, by which we lost a storage of about 5,000 million cubic feet, and consequent on damage to Pillowa, which is situated below the Tigra reservoir, the storages of Kotwal and Pillowa lakes also were lost. Thus the entire irrigation (50,000 *bighas*) was done by the storage of Pagara lake. The repairs of Pillowa could only be completed by the end of December and though the cultivators were given hopes of water they were distinctly led to understand that none could be made available before January. Thus when actual irrigation began in this year there was keen demand for water and the number of waterings did not exceed two, and in 50 per cent. of fields was only one. The quantity consumed was 1,680 million cubic feet which, on an irrigated area of 50,000 *bighas*, gives a duty of 30 *bighas* per million cubic feet.

5. Irrigation season of 1918-19.

This year was a year of extreme drought and from the very beginning every body concerned was given to understand that no waste would be permitted and the minimum number of waterings required would be given. In addition to this, a very strict supervision was kept on the use of water and the department set its face against giving water to the tail portion, as it was seen that it would be better to irrigate the maximum area possible nearer the head-works to obviate loss by absorption, instead of supplying inadequate water to the tail portion. The staff was explicitly ordered not to extend irrigation beyond the irrigation capacity of the storage and

to reserve sufficient quantity for a second watering where needed. The number of waterings also was restricted to two. In a very small portion three waterings were given and in an equally small portion one watering was necessary to save the *kharif* crops. Thus, this year may be considered to be the first year of comparatively economical use of water. The sympathies and co-operation of the irrigators were enlisted by assigning quantities of water at different out-lets and appointing *chowdharies* for equitable and economical distribution among themselves, and very severe notice was taken of any wastage, a special staff being deputed for the purpose, in addition to the regular revenue staff. These measures reflected themselves in the high duty obtained. The net quantity used on the fields works out, for this year, to 1,540 million cubic feet and the area irrigated was 60,000 *bighas*. This gives a duty of about 40 *bighas* per million cubic feet, which is very good and clearly shows that, by the introduction of economical methods of distribution, a much higher duty can be obtained.

The experiments of Lawes and Gilbert show that pulses take 10,000 cubic feet of water for actual transpiration; but some waste is incidental in application as, the crops being embedded in loose soil, the subsoil absorbs a great deal of water while the plant is growing.

If we allow 5,000 cubic feet for this, the quantity per *bigha*, under scientifically rigorous conditions of application, comes to about 15,000 cubic feet. The theoretical duty of 30 *bighas* per million cubic feet gives 33,000 cubic feet per *bigha*. From this it will be seen that by the introduction of economical methods of application it is possible to raise the duty per million from 30 to 70 *bighas* for crops requiring two to three waterings. If we follow the advice of Mr. Howard of Pusa and raise wheat, gram and cotton on one watering, it is quite possible to attain a duty of over 150 *bighas* per million cubic feet. The importance of introducing economical methods of irrigation is evident from this. The only way to ensure this is to introduce the system of charging by measurement. The present system is to charge by cropped area, irrespective of the quantity of water used. If the crop is in a flourishing condition,

it is assumed that adequate water must have been allowed and full rate is charged. If a twelve or eight-anna crop is produced, the water rate is reduced proportionately on the assumption that adequate water was not supplied. Nothing, in some cases, is farther from actual fact. Wherever inferior crops result, they are due to any one of the following reasons, singly or in combination :—

1. Copious use of water.
2. Want of aeration of roots.
3. Want of weeding.
4. Situation. Low depression, where water accumulates and prevents soil ventilation.
5. Poverty of soil and absence of manuring.
6. Untimely application of water. Application of water is necessary when the plant is thirsty. The Gwalior irrigator, acting on the principle of "take when you can and not when you may," always gives an early, unnecessary, and abundant watering. It prevents the roots of plants getting oxygen and acts as a toxin.

The Irrigation Department has often to remit watercess for fields which have consumed double the quantity of water supplied ordinarily to an equal area producing normal crops! Is this not setting a premium on wastage? The charge by measurement will obviate this. If we supply a given quantity of water at the out-let for so many rupees per million cubic feet, it will be in the interest of the irrigator to make *kiaries* and use water as economically as in the case of wells. When the purse of the irrigator is touched, he responds with alacrity to wholesome stimuli. It is rather early to introduce sale of water by measurement in Gwalior, as elsewhere in India, but I desire to bring the subject prominently to the notice of the revenue and agricultural officers, with a view to enlist their sympathies to facilitate its adoption as early as possible. I commend for their careful consideration the lessons brought out by Mr. Howard in the Pusa Bulletins Nos. 52 and 61. I have put in the thin end of the wedge by charging eight annas for one watering, even in case of a sixteen-anna crop, to enable

the irrigator to realize that he pays only 33 per cent. of the full rate R. 1-8 if he gives one watering instead of two, three or four. A motive is thus supplied for economy. When this begins to work well and the State Agricultural Department establishes by demonstration that wheat and pulses can be raised on one watering, provided soil aeration and root ventilation is ensured, it will be time to drive in the wedge deeper and to introduce the system of charging by measurement.

THE DRYING OF BANANAS.

BY

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AND

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In the "Agricultural Journal of India" for July 1911, there appeared an article by L. B. Kulkarni, L.Ag. (a colleague of the present writers), on *The Drying of Plantains at Agashe.* Since that date and especially during the war, when the food question was urgent, experiments have been made by us in the drying of bananas to determine (1) whether varieties of bananas other than the one used at Agashe could be dried, (2) to see whether there were any reasons why bananas should not be dried at other places than Agashe, and (3) to devise and to develop a cheap and efficient means of drying bananas on a large scale.

In this article the word "banana" is used for any fruit of the plant *Musa sapientum* (or *Musa paradisiaca*). The distinction of the fruits into bananas and plantains has always seemed to us vague and confusing.

Banana-drying is an art of some antiquity. Fawcett[1] gives several references from the works of early travellers. The following may be quoted[2] from the works of Dampier (17th century): "The Darien Indians preserve them (bananas) a long time, drying them over the fire, mashing them first and moulding them into lumps." "A ripe plantain, sliced and dried in the sun, may be

[1] Fawcett, W. "The Banana," 1913.
[2] *Ibid*, p. 109.

preserved a great while, and then eats like figs, very sweet and pleasant." Pere Labat[1] (17th century) also writes: "To preserve them (bananas) like figs, raisins and other dried fruits, they are allowed to ripen thoroughly in the house, in which condition the skin is very easily removed; they are then cut lengthwise into four, and dried on a trellis-like stand in the sun or in an oven after the bread has been baked; the fruit becomes covered with a white sugary powder deposited from its own juices. In this condition they will keep for years."

Fawcett states that banana "figs" (dried slices) are being manufactured and exported from Jamaica. In India, Travancore is the only other place besides Agashe that he mentions as a home of banana-drying.

In Fawcett's book and in various other treatises on foodstuffs, analyses of the unripe and ripe banana are given which show that it is a valuable nutritive substance. Drying of it means the production of a store of easily preserved food against famine or to vary a diet. Moreover, in many places a certain number of banana fruits go to waste for want of an immediate market. The drying of the fruits would obviate this waste.

Preliminary experiments and difficulties.

The earlier experiments were carried out in Bassein, a town on the west coast of the Bombay Presidency with a climate similar to that of Agashe. Bassein is practically at sea level, its average rainfall is 83 inches, and its temperature in the shade during the whole year is very equable owing to the nearness of the sea, the mean maximum temperatures for January and June being 87° and 91°F., and the mean minimum temperatures 60° and 78°F. Drying was first of all done in a small wooden box open to the sun on the upper side. The varieties *Rajeli* and *Tundo* were used. This was in December 1916. The bananas thus dried developed maggots in March of the following year.

The next lot were dried in April and May 1917. In this case the following varieties were used: *Basrai, Bankeli, Budubali, Satsalandu,*

[1] *Ibid*, p. 113.

Mutheli, Red, and a yellow sport of Red. The open side of the box was covered by muslin or wire gauze. The bananas were taken out of the boxes at night, and kept indoors to prevent them being damaged by dew. One or two boxes were covered with glass panes and these with the bananas drying in them remained out night and day, but were covered at night with gunny bags. After drying the bananas were packed in small bundles, wrapped in banana leaf-sheaths, and put in biscuit boxes. These were sent to Poona where they were kept in a room in the Agricultural College on a shelf without any special protection.

In the manufacture of this batch two points arose. In windy weather bananas under gauze or muslin were apt to get covered with dust. Also ants sometimes crept up into the boxes and attacked the bananas. It was therefore obvious that boxes with glass covers were best and that they should rest on stands with their legs in bowls of water to prevent the ascent of ants. This batch was re-examined in September 1917, when some packets were found to be sound and others maggoty.

Final form of the drying apparatus.

An apparatus was now devised which obviated all causes of failure. It is shaped like a flat museum show-case supported on four legs (Figures, 1, 2 & 3). Each leg is two feet in height.

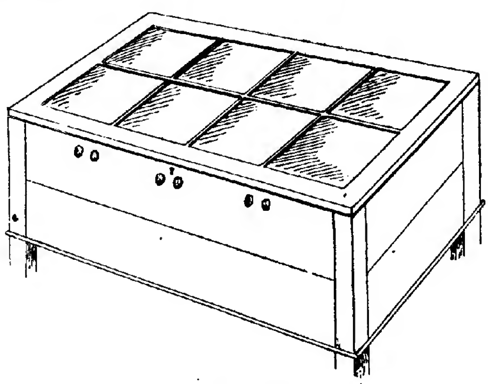

FIG. 1. Banana-drying case.

The box used was one foot broad by four feet long by two feet deep, but may of course be of any size convenient. The lid is of glass,

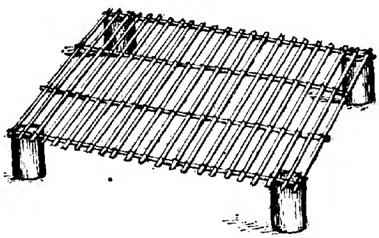

FIG. 2. Framework for bananas.

hinged on to the body of the box. All joints should be insect and dust proof. In the floor and in the two long sides of the box are eighteen ventilators, round holes about half an inch in diameter, six to each side and six to the floor. These are closed by wire

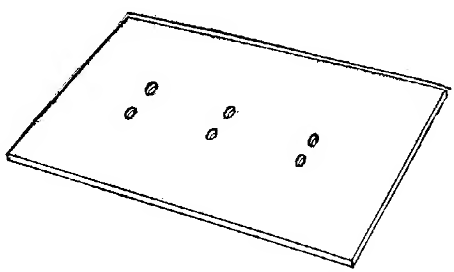

FIG. 3. Bottom plank of the drying case.

gauze inside, and there are also bungs for stopping them up entirely at night. A false floor of cane lattice-work rests on four blocks four inches tall on the bottom of the box. This is the actual tray on which the bananas rest.

Experiments with this apparatus were carried out in Kirkee, elevation above sea level 1,850 ft., rainfall 27 inches per annum, maximum average temperatures January and June 85°F. and 86°F., minimum average temperatures 53°F. and 72°F.

In November 1917, several varieties of bananas were dried in the above apparatus and exhibited at the Food Products Exhibition

at Calcutta in January 1918. The dried bananas on being taken out of the apparatus were packed in wide-mouthed glass bottles, the mouths of which were luted with paraffin wax. Some of these bottles got broken in transit. The contained bananas were taken out and repacked in other bottles. These bananas showed mould after a few weeks. The others remained sound.

Further experiments.

In April 1918, the following varieties were dried: *Karanjeli, Kalhi, Bankeli, Walhe, Soni,* and *Rajeli.* Half of them were wrapped in oil-paper and packed in tins, the other half were put loosely into glass jars. They were examined in June and September 1918, and finally on May 5, 1919. At the first examination it was found that two bananas of the *Kalhi* variety showed a growth of mould. These two were removed and the whole lot that had been in contact were exposed again to the sun for one day and repacked. There was no further attack. The rest of the bananas were sound all the time, and some were still sound in October 1919, having kept eighteen months.

It seemed that it was advisable to examine the bananas periodically in order to check any possible growth of mould. An examining box consisting of two panes of glass in a frame, so that the examiner can put his eye close to the fruit without breathing on it, was devised and is useful.

Developing a desirable colour.

Under strong exposure to the sun bananas tend to take on deep colours and in weaker exposure the colours are pale. Bananas that have dried brick-red often turn black on keeping. A bruised or over-ripe part dries black. The product takes the final colour about two days before the final drying. The ideal is pale saffron as a finishing colour, so that, after keeping, an attractive shade of red will be visible. This is obtained by using bananas that are exactly ripe but not over-ripe, and by putting a cardboard over the dried or rather drying bananas in the box for the last two days of the

process. This method applied in February 1919 gave an excellent saffron-coloured product that had turned a red in October 1919, and remained perfectly sound.

The process.

The following is a résumé of the process:—

(1) Get fully ripe but not over-ripe fruits.
(2) Peel them and scrape the outside of the fruit with a bamboo scraper to get rid of all shreds of skin.
(3) Put the peeled bananas on the cane lattice tray and shut the lid; put the frame out in the full sun, with its legs in water bowls.
(4) When the temperature begins to fall below 95°F. in the sun close the ventilators with bungs.
(5) At night cover the whole frame with a thick gunny bag, or (if rain is expected) with a tarpaulin.
(6) Turn the fruits daily. It will take from four to six days for the fruits to dry. Finish under cardboard as described.
(7) Pack in tins or jars with tightly closed mouths.
(8) After two months look over the batch, pick out mouldy or maggoty bananas and expose those of the same tin or jar for a day to the sun in a frame.

Twenty to thirty moderate-sized bananas make one pound of dried material.

Nature and uses of the product.

The material finally made by us is a most delicious sweetmeat eaten raw. It can be made into excellent jam. While one of us was on leave in England, he received from the other two biscuit tins of dried bananas. The first was packed on 26th March, 1919, and opened on 12th May, 1919. The fruits were in perfect condition and remained so although exposed to the air till 11th June, when they were cooked. The other was packed on 1st May, 1919, and

opened on 11th June, 1919, and made into jam. This was most heartily appreciated by all who tasted it.

The dried material can be used for making up into various dishes, such as puddings or various Indian preparations.

Conclusions.

Bananas can be dried at other places than Agashe, and all varieties that we have experimented with can be successfully dried.

Sun heat is sufficient.

Protection from dust and insects is necessary, and some sort of simple apparatus such as that described by us is required.

A good colour can be obtained by using a cardboard screen for the last two days of the drying.

The product should be stored in airtight tins or jars and examined periodically, throwing away bad bananas and drying again those likely to have been infected.

We have indicated only the simplest possible method of drying, one suitable to the most primitive conditions. Doubtless if there were an assured market, vacuum driers and modern scientific apparatus would be desirable. In the meantime all we wish to show is that by a very simple apparatus a valuable and easily stored food can be made from a perishable fruit.

After writing the above, the writers' attention was drawn to an article[1] describing experiments on the drying of bananas in Jamaica. The main conclusions of these experiments of interest to India are:—

(1) The sun-dried product is superior to the product artificially dried in a drying apparatus.

(2) With a good supply of sound fruit at 1*d*. per lb. and a selling price of 6*d*. a lb. a profitable industry could be established in the West Indian islands.

(3) Fruit merchants in the United Kingdom valued the sun-dried bananas at 6*d*. per lb. there wholesale in July, 1919.

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[1] *Agricultural News*, September 6, 1919, p. 276. Article on "A Dried Banana Industry," unsigned.

PS.—On 28th August, 1919, a sample of bananas dried in the above manner was sent by us to the Chamber of Horticulture, London, for opinion.

That body sent on the sample to a firm of specialists in the banana trade who reported as follows :—

Elders and Fyffes, Limited.
Head Office,
Bow Street,
London, W. C. 2.

Report on Dried Bananas received from the Secretary, Chamber of Horticulture.

"The tin box contained four small parcels, two marked 'Black Colour' and two marked 'Red Colour.' All four parcels are in perfectly good condition and sweet. An outstanding feature is the complete dryness of the fruit, in which it compares favourably with the Jamaican variety. All the fruit is of good flavour.

"The samples marked 'Red' are much brighter and more attractive in appearance than those marked 'Black,' and the sample marked 'Red 1' is the best in every respect.

"During the past thirty years many attempts have been made to introduce dried bananas into this country, notably from the Canary Islands, but meeting with poor results the efforts have been short-lived."

"During the war small consignments were imported here from Jamaica and sold readily owing to the scarcity of other dried fruits, but at the present time, notwithstanding the continued shortage, the demand at remunerative prices is negligible.

"It is difficult to speak hopefully of the prospects for the future as it is thought that in normal times the competition of other products of a similar character will be to the disadvantage of the industry.

"14th November, 1919."

PACKING SEED SUGARCANES FOR TRANSPORT.

BY

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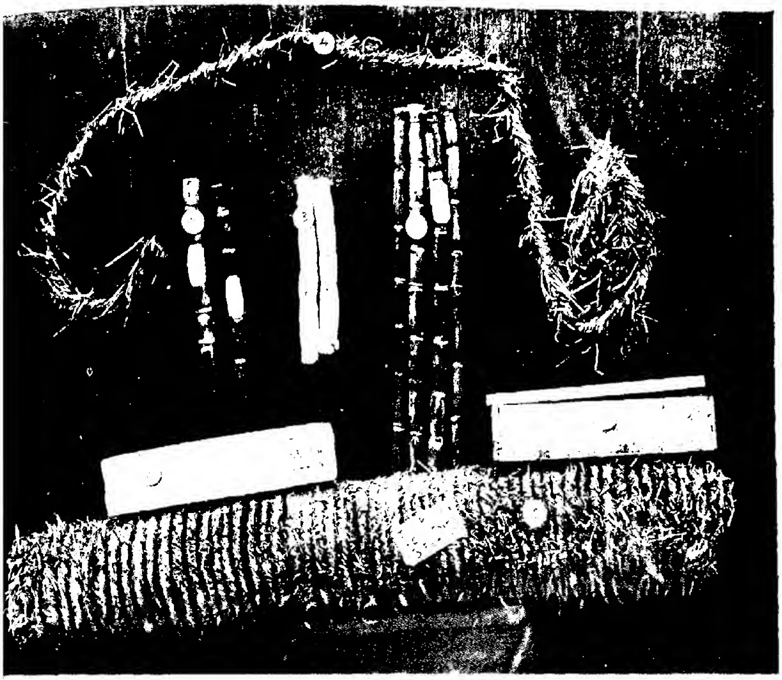
Acting Government Sugarcane Expert, Coimbatore.

INTRODUCTION.

EXPERIMENTS to ascertain the best method of packing sugarcanes for transport, as seed, have been engaging the attention of the Cane Breeding Station, Coimbatore, from its very inception in the year 1912, as it was early realized that such transports were bound to play a very important part in the future work of the station. Further, the requirements were soon found to be of a varied character, both as regards time occupied and mode of transport, whether as parcel by rail or steamer, or as packet post. The need frequently arises for sending out details of packing to would-be consignors, and this note, based on the experience of the station for the past seven years, is written to give a wider publicity to the methods employed, as they have proved successful. The methods described herein were evolved under the guidance of Dr. C. A. Barber, C. I. E., and Mr. R. Thomas, Sub-Assistant at the Sugarcane Breeding Station, greatly helped in the details of the work. Two plates (Plates XI and XII) are appended to illustrate the methods described in this note.

Because of the possibility of obtaining planting material even from immature canes, and the rapidity with which a single sugarcane bud gives rise to shoots ultimately developing each into one cane, it is unnecessary, except when absolutely required, to transport a large number of canes as planting material from one place to another.

PLATE XI.



PACKING OF SEED SUGARCANES FOR TRANSPORT.

—Canes cut to four-foot lengths and ends dipped in paraffin for short distance transport.

—Cane pieces cut to lengths of one foot three inches, and treated as detailed in the text for oversea consignments.

—The same after being wrapped round in cloth.

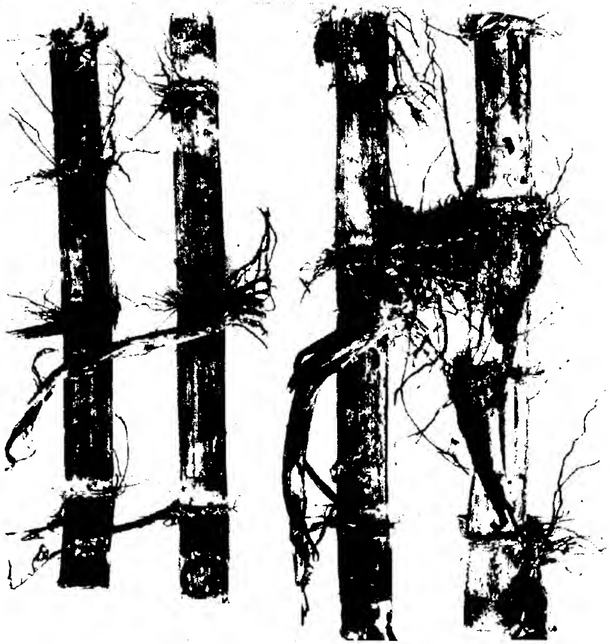
—Paddy twist as used in such consignments.

—Bundle of canes tied round *tightly* with paddy twist and ready for being enclosed in gunny. (For short distance transport.)

—The oversea postal packet ready for forwarding.

—A tin case used for oversea packets.

Note the labelling of individual pieces for oversea consignments and the manner in which the labels are attached to the canes.



Canes packed for overseas, but kept at the station for testing, and opened after 64 days from date of packing. This lot contained 14 buds and planting gave rise to 13 healthy plants.

A postal packet from Antigua. *The journey occupied 58 days.*

Theoretically, it may be assumed that, in one year, a single bud is capable of giving rise to about 100 buds in the case of the thick canes and 300 buds in the case of the indigenous varieties. It, therefore, follows that, in a couple of years, one can hope to raise 100 plants from one bud of a thick cane and 300 plants from that of a thin cane. The aim kept in view was, therefore, more to transport a few buds in a healthy condition than to send out a large number whose vitality at the end of the journey was likely to be of a doubtful nature.

CERTAIN MAIN CONSIDERATIONS.

It was soon realized that the three most important considerations in the transport of cane material for packing were :—

(1) Protection of the cut ends, to prevent evaporation and the consequent drying up of the material during transport.

(2) Protection of the buds, to prevent their rubbing against one another or against other cane surface during the journey, resulting in their being rendered incapable of germination at the end of it.

(3) Treatment of the material, to prevent entry of disease through the cut ends and, if possible, to destroy any disease that may already exist in it.

THE MATERIAL.

The selection of proper material is an item of great importance in the transport of cane for seed. The clump selected for obtaining material from should be healthy and vigorous. Occasionally, a clump which, on the whole, is poorly and stunted, may show up a healthy cane or two ; but it is better to avoid such a suspicious material. Tops of canes do not journey satisfactorily, while pieces obtained from " butts," especially when the canes are fully mature or overmature, not infrequently contain buds which are hollow and therefore incapable of germination. The appearance of such buds is often very deceptive and their real condition is often ascertainable only by exerting a certain amount of pressure on

them with the fore-finger. Generally, the middle portion of a cane, not overmature, yields the best material for transport. The ideal pieces for packing should possess buds, firm to the touch, not at all swollen or bursting and with no visible external injury, either in the buds or in the adjacent internodes.

Before removal to the place of packing, the selected canes should have the leaves and tops removed in the field itself, as, otherwise, these by transpiration take off too much moisture from the canes.

Treatment and packing for short-distance transport by rail or steamer.

At the packing shed the canes are cut to four feet lengths—or to any length considered suitable for the parcel—and the freshly cut ends dipped in paraffin wax kept ready melted for the purpose.* This is done to prevent the drying up of the canes during the journey by evaporation from the cut ends and to prevent the entry of disease through these ends. The pieces belonging to the same variety are now bundled together, *not too tightly*, with some soft material between individual pieces. Loose paddy, *ragi* (*Eleusine coracana*) or wheat straw or some fibrous material such as sann, *gogu* (*Hibiscus cannabinus*) or coconut fibre have been found useful for the purpose. In very dry weather this packing material receives a sprinkling of water to prevent too much desiccation of the canes during transit. While bundling up, care should be taken to see that the coir, or other material used in binding, does not come into direct contact with the cane pieces, especially the buds, as the slight movements which are inevitable in the further processes of packing and actual transport are sufficient to destroy the buds. These individual varietal bundles are then labelled both inside and outside and all united together into one parcel by being tied round *tightly* with paddy twist. This is then stitched round *tightly* with gunny, addressed, and is ready for despatch.

* For this and similar other purposes mentioned in this note, white paraffin wax melting at 135-40°F. has been found suitable. The paraffin is placed in an iron or porcelain basin, sunk to below its mouth in a bucket of water and the water brought almost to the boil. This melts the paraffin in the basin and keeps it in this condition for some time.

For railway transport it is advisable not to make the bundles too small, as they are then liable to be thrown in and out of railway carriages. These packages should be of such a size as to require rolling over. Most railways now insist on the addresses being written directly on the gunny and the packages are safer thus.

Such transports are generally between places where there is no risk of introducing a new pest from one locality to another, and, therefore, the material is not specially treated with insecticides or fungicides. Care is, however, taken to see that the material is free from disease by a very careful examination both in the field and in the packing shed. If the material to be transported consists of but a piece or two, these are best sent by parcel post, which, on occasions, is cheaper as well. Such post parcels need a greater amount of packing between the individual pieces because of the greater liability to desiccation and handling in this form of transport. In the experience at the station this method of packing has been found to be adequate for journeys extending to periods up to at least a month.

Treatment and packing for oversea consignments.*

In oversea consignments the conditions during transport are more strenuous and a more elaborate method of packing than that described above is required.

Large-sized boxes are unsuitable because of (1) heavier transport charges, (2) slowness of the journey, and (3) greater liability to damage in transit unless very expensively packed. Small-sized tin cases, 18″ × 4″ × 4″, with the lids made like that of a pill-box, and forwarded by post, have been found the most suitable. If these are carefully japanned both inside and outside to prevent rusting, and strengthened with bits of iron rod placed along lines of greatest strain, these may be used over again at least twice.

* A description of the method as adopted in the West Indies is to be found in the *Agricultural Journal of India*, IX, 4, p. 392.

In such consignments which are generally over long distances often separated by seas, the transported material requires treatment to prevent the unwary introduction of diseases from one locality to another. Besides the very rigorous examination in the field and in the packing shed, the cane pieces are pickled from half to three-quarters of an hour in a 4 per cent. solution of copper sulphate or Bordeaux mixture of similar strength. After removal from the solution, the ends are wiped clean, allowed slightly to dry, and then dipped in melted paraffin wax.

For oversea consignments the packing material requires to be softer and finer, and well-sifted charcoal dust—copied from West Indies practice—has been found satisfactory. An additional protection is given to the canes by wrapping them individually in bits of thin cloth. Such journeys often extend to two months—during the war it occasionally used to take even three months—and so a certain amount of moisture is provided in the packing material to prevent drying of the canes during the voyage. The most satisfactory proportion has been found to be, as much weight of dry charcoal as weight of canes to be packed, and half its weight of water to be added to the dry charcoal powder. A series of elaborate experiments, involving the packing of sixty tins, with different materials for pickling, packing and wrapping the canes and with varying quantities of water added to the packing material, has shown—

(*a*) that charcoal powder may be substituted by "teak saw-dust" without any disadvantage;

(*b*) that wood shavings—the packing material received with Europe stores—may be substituted for charcoal with advantage; with this packing, the parcels are lighter and the buds travel better; and,

(*c*) that formalin of varying strengths as pickling solution and tissue paper as wrapping material are unsatisfactory.

The tin cases are now wrapped in brown paper or newspaper—just a layer or two—stitched *tightly* round in white cotton cloth and addressed. A duplicate addressed label, treated with paraffin, is enclosed inside the cloth packing and is sufficiently visible through

the cloth to enable the package to be directed, should the addressing on the outside become indistinct during the journey.

Labelling cane material intended for transport.

This most important item is occasionally not done with sufficient care. One cannot lay too much stress on its importance, as bad labelling may involve the complete destruction of the whole material, at the end of the journey, as unreliable for accurate work, or, what is worse, introduce serious errors in naming.

For short-distance transport it has been found a good plan to write the labels clearly in pencil or ink, dip them in melted paraffin, and fasten to the pieces with strings similarly paraffined. This treatment makes them proof against injury through moisture or dirt during the voyage. Should they get soiled however, all that is required is to wash them in water, to make them appear as bright as before. Such labels should be fastened adpressed to the canes and not allowed to hang from them, as in the latter case they are liable to be torn or otherwise mutilated in the subsequent handling of them. Every individual varietal bundle should possess two such labels—one inside and fastened to one of the cane pieces, and the other outside attached to the bundle.

For oversea consignments the usual practice is to use a tin or zinc label punched with the name or number of the cane and attach it directly to the cane with a piece of wiring. This is satisfactory, but experiments conducted at the station have shown that the paraffined labels described above serve equally well and possess the following advantages besides :—

(1) They are cheaper and neater. The metallic ones are often not easily decipherable at the end of the journey on account of rust except after careful washing.

(2) Because of their greater pliability, they are easier attached to the canes and less liable to injure the cane surfaces or the buds.

(3) These are not liable to rust as the metallic labels or the wiring, a common source of trouble in such consignments. Such labels, whether of metal or paraffined

paper, are best placed inside the cloth wrapper and next to the canes. In the case of oversea consignments it is important that every piece should be individually labelled.

For some time past the idea has been steadily gaining ground that in the transport of cane material for planting the internodal portions are unnecessary, and experiments are under weigh to further simplify the oversea packing by including only the nodes.

SWARMING CATERPILLARS OF NORTHERN GUJARAT.

BY

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In the early part of the monsoon of 1919, after the long and almost unprecedented drought which had resulted in the famine of 1918-19, the people were alarmed to find that their crops were attacked by swarms of small dark brown caterpillars, which appeared likely to do a very great deal of damage. These pests attacked the early sown crops of maize, *bajri* (*Pennisetum typhoideum*), *kodra* (*Paspalum scrobiculatum*), and chillies, while rice seedlings and grass on the higher lands were also much damaged. They seem to be confined to the parts of Gujarat where a light (*goradu*) soil occurs, but in these regions they were found in Surat, in Kaira, in the Panch Mahals, and in Baroda.

The pests, though not unknown previously, had never occurred in anything like the abundance in which they were found in the present year. The first sign was usually a certain amount of destruction of the leaves of the crop. Sometimes on an examination of the leaves at this stage a group of small brown caterpillars was found: sometimes the caterpillars were larger, coloured a velvety black or grey brown with stripes of dark and yellowish grey on the back and sides, with black spots. In the case of the cereal crops above named, at this stage they were often found in the funnel composed of the leaf-sheaths round the central shoot of the plant. When examined the pests revealed themselves as two well-known swarming caterpillars, *Prodenia litura* and *Cirphis loreyi*, recognized as most serious pests of crops in many parts of the tropical world.

The source of the exceptional attack in 1919 was probably the absence of rain for a very long period. The caterpillars pupate in the ground, chiefly in the higher land, at a depth of two to three inches. The pupa is unprotected by a cocoon, and simply is enclosed in a small chamber of earth. Under conditions of normal moisture, it remains in this condition from one to six weeks, but with the exceptional drought it is quite possible that the pupæ may have remained much longer than this time. At any rate the first rains of the second week in June were followed by a very large emergence of moths which laid eggs on many plants, but particularly on the early sown crops and on the grasses which were just springing up. As each female moth was found to lay about five hundred eggs, in several masses, along a leaf, and as these eggs hatch in about four days, it will be easily seen that by the end of June the small caterpillars were spreading over all the suitable crops growing at that time. As the caterpillars grew older, they were found feeding especially in the early morning, evening, and at night. During the hot part of the day they were chiefly hiding in the soil or concealed at the base of the leaves of the plant attacked.

Most of the caterpillars which appeared at the end of June disappeared in the third week of July. Those which had become full grown retired to pupate in the soil; others were very much parasitized by tachinid fly parasites. These latter parasites were found as small maggots on the viscera of the caterpillars, while their eggs were noticed also on the surface of the worms. At this time, too, there was a good deal of heavy rain, and on examining the soil of the higher lands, a good many (in fact, by far the majority) of the pupæ discovered were found to be in a decomposing state, probably as a result of the wet conditions in which they found themselves.

Partly, therefore, as a result of the parasites which had appeared, and partly on account of the seasonable rain, the much dreaded second brood, which should have appeared early in August, never came out in any serious numbers, and the alarm which had prevailed widely in the early part of July gradually disappeared. The

observations which were made in connection with this attack, however, lead to a number of methods which will, if widely practised, probably prevent the attack of these caterpillars being serious another year.

The first of these preventive measures is to have the land ploughed up before the rains come, or still better as soon as the previous crop is harvested. By this means the pupæ which will certainly be in the ground will be turned up, and either dried out by exposure to the sun, or devoured by insectivorous birds. In this connection it appears especially important to plough up the high lands, and the strips of grass so often found between fields. The ploughing up of these latter once every two or three years will assist a good deal in controlling several insect pests of the crops.

The moths, at least of *Cirphis loreyi*, are, moreover, easily attracted to light, and if the fields are provided either with a number of lamps each standing in a tray of kerosine and water, or with a few fires made of dry brushwood for a few days after the first rain and the consequent emergence of the moths, a very large number will be destroyed before they have had the chance to lay eggs.

Again, a good deal may be done by delaying, for a few days, the sowing of the crops. It is a frequent practice to sow crops as soon after the first rain as possible. This was done very largely in 1919, and the crops so planted were those most attacked. The crops planted a fortnight later, the time between having been used for ploughing, harrowing, and otherwise preparing the fields, were hardly attacked at all. This is in accordance with what is known of the life-history of the insect, and would probably apply equally in another year.

If these precautions be widely taken, little else will be needed, though the employment of children to collect and burn the leaves, on which the very prominent egg masses have been laid, might pay in special cases. The same children might also collect leaves on which the gregarious swarms of the very young caterpillars are feeding. It might also be worth while, in the case of seed beds or fields of valuable crops, to put a trench round the bed or field, in

which green stuff or grass can be put in the evening. The large caterpillars sheltering in it can be destroyed on the following morning.

While the pests here discussed do not seem in any sense to be pests of the first importance, the widespread alarm and damage which they caused in Gujarat in the present year would seem to justify attention being called to them and indications being given of how a similar attack can be prevented or dealt with in future years.

Selected Articles

THE GROWTH OF SUGARCANE.*

BY

C. A. BARBER, C.I.E., Sc.D., F.L.S.

I.

It is proposed, in the present and succeeding articles, to discuss certain points connected with the growth of the sugarcane. The average planter has little time to conduct researches on plant growth in the field, and, naturally, leaves these to the officers attached to the experiment stations. But these researches are often expounded in highly technical language, assuming a thorough knowledge of plant morphology and physiology. It is also too often forgotten that they have been conducted under one great disadvantage, for the conditions in the small experimental plots, with their intensive cultivation, are very different, in most cases, from those in the large cane fields. All laboratory results have, therefore, to be checked, that is worked over again, in the field conditions, and it is of great importance that they should be expressed in as simple and attractive terms as possible. But, independently of this, there are many directions in which the planter can quite easily make observations and carry out experiments of his own for the improvement of the crop, instead of blindly following local custom in all its details. The chemist has shown that the manurial requirements of the cane vary with the soil, its treatment, the climate, and the variety planted; and it is probable that there are other sides of field practice

* Reprinted from *The International Sugar Journal*, October 1919.

which should also be modified according to variation in these conditions. Even on adjoining estates small differences occur, and it is only the man on the spot who is aware of these. But to reap the full advantage of such work requires a fairly thorough knowledge of what goes on in the cane field, and how the cane set, planted in the ground, increasing a hundredfold, gives rise to the great mass of canes which are cut at harvest time. It is for the agriculturist, then, that these articles are written. They will not be loaded with technicalities, and their ultimate object will be to indicate in what direction observations and experiments can be made in the field, so as to produce healthier plants and a greater crop of ripe canes at crop time.

The parts of the sugarcane above ground, the stalks, leaves, shoots, and flowers, have received a great amount of attention, and many interesting facts have been noted in the fields. But, once the cane set is planted, little is to be found in current literature as to what changes take place before the cane shoots appear above ground. It will be fairly obvious that the number of shoots emerging and the vigour of their growth will depend, in the first instance, on the development going on in the soil. Here the foundation is laid for the future plant, and the production of a good crop of canes is dependent on the proper treatment of this foundation. The length and thickness of the individual canes, the even ripening of the crop, the tillering power of the variety planted and the total yield of canes and sugar at harvest, are all decided in this subterranean laboratory.

As is well known, the sugarcane is always planted in the field from sets, pieces of the mature cane with three or four buds, or the "tops," immature joints with a greater number of less developed buds. Each of these buds is itself capable of producing a full-grown plant, and the reason for planting several of them together is to ensure an absence of blanks, which are such a serious drawback to any field crop. For a study of the development of these buds, it will be convenient, for our purpose, to consider the growth of the cane plant from the actual seed. The stages are the same in both cases, but the growth from the seed is much slower, and we can better

PLATE XIII

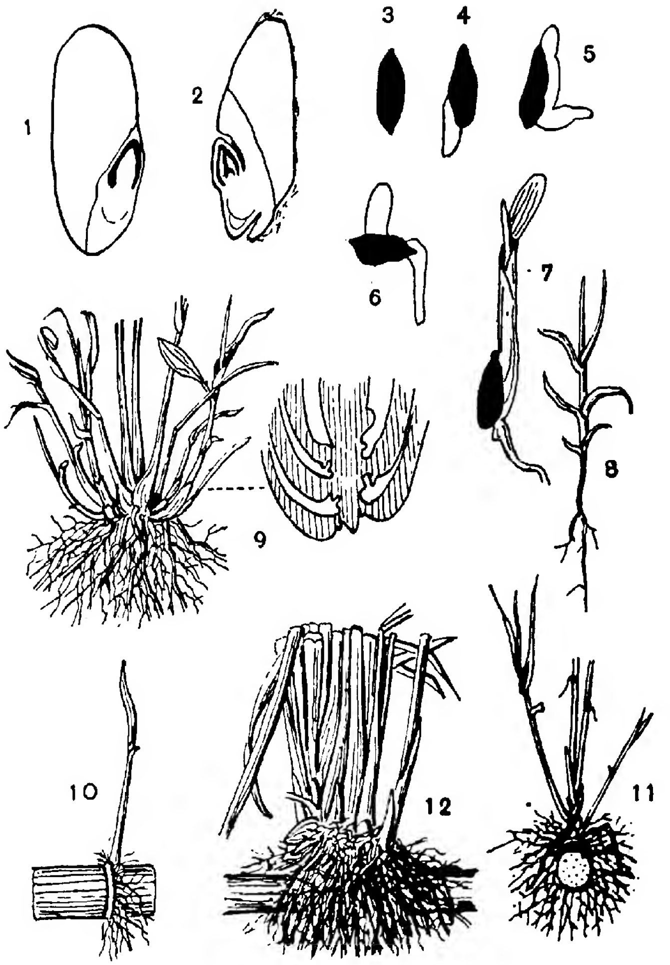

Fig. 1. Vertical section through a sugarcane seed; Fig. 2. through one commencing to germinate.

Figs. 3—7. Germinating cane seedlings, three-four days old. Fig. 8, an older stage showing the two rows of leaves on the stem.

Fig. 9. A four months old seedling with its bunch of leaves and mass of roots; at the side the same bunch has been dissected out to show that the leaves are really, as in Fig. 8, all in one plane.

Fig. 10 A germinating set, showing the root development from its root-eyes.

Fig. 11. A later stage with two thick roots from the joints of the young plant.

Fig. 12. A cane plant 50 days old, still attached to its set.

learn the way in which the strength and vigour of the plant are built up and the way in which the branches are formed, by following the stages of growth in a seedling cane. The seed of the sugarcane is excessively small, and many of the "arrows" or "plumes," so delicate and beautiful in the fields, contain numbers of seeds hidden away among minute, chaffy scales. The arrow of the cane is thus, in essentials, similar to an ear of corn, although few people would imagine that these were anything but a mass of feathery grass flowers. The average cane seed is 1·5 mm. long and 0·5 mm. broad. It is somewhat of an anomaly that, while these are among the smallest of grass seeds, the full grown plant is such a giant among them, for the cane plant is nothing but a huge grass. A series of germinating cane seeds (greatly enlarged) have been drawn on the accompanying plate (Plate XIII, figs. 1–7). Anyone acquainted with the germination of wheat or barley grains will at once recognize that the parts are practically identical. But the amount of nutriment in such a small seed must, of necessity, be extremely limited, and therefore the vitality of cane seeds is not great. They quickly dry up and perish—a fact which is no doubt responsible for the comparatively recent discovery that the sugarcane produces fertile seed at all.

The mature cane consists of a series of joints, each of which has three essential features in its lower part, a leaf, a bud immediately above it and a narrow ring of tissue covered by small dots or root-eyes. The leaves and buds are placed on the cane stem alternately, right and left, in one plane, accounting for the fact that the terminal tuft is so often shaped like a fan. This arrangement is seen in the young cane seedling from the start (Plate XIII, fig. 8). The joints are extremely short at first and as there is not room for the leaves to develop and expand in the same plane, they appear at the surface of the ground in a bunch, evenly distributed round the stem. But a careful dissection shows (Plate XIII, fig. 9) their true arrangement, and that they are in two vertical rows on opposite sides of the stem, just as in the mature cane. The leaves grow much more rapidly than the stem, so that the first part of the plant appearing above ground is a number of leaf tips, the stems not emerging until their leaves are three or four feet long. The first joints of the future cane may, soon

after this stage, be detected between the leaves at the base of the plant.

But this description only accounts for a single cane shoot. At a very early stage, the minute buds above the individual leaves, that is to say, in their "axils," also start growing out, and form shoots in all respects similar to the parent stem. They, likewise, have their parts arranged in one plane, and here again a struggle for space causes the leaves to push one another aside, and bunches of leaves appear above ground. We thus get a further complication in the arrangement of the parts of the growing plant; but we know from our dissections that all the leaves and stems of our branching cane plant could, theoretically, be pressed flat in one plane, as on a piece of paper. The way in which this redistribution of space is brought about need not detain us here, but there is, obviously, a good deal of torsion and twisting going on underground, before each organ is able to find its place in the air and light; and, in the process, many fail to do so and are squeezed out of existence.

There are, as in all grasses, two periods of growth in the sugar-cane. The first of these (as far as the stems are concerned) is underground, where branching takes place, the second when these branches are pushed into the air and rapidly assume the form of separate canes. But the success with which the latter action is carried out depends entirely on that of the previous underground preparation. This, then, is, for our purpose, the more important period of growth, for the work done then regulates the tillering capacity of the whole plant and the number of canes produced. Each branch of the main stem, termed a branch of the first order, soon gives rise to branches of the second order, still in the same plane, and the whole complex becomes more and more intricate and difficult to dissect out, so as to show the true relations and positions of the various members. We ultimately see a considerable bunch of canes, and the number depends largely on the space available, that is, the nearness of the organs to one another and of each plant to its neighbours.

Now all this branching takes place underground in the first period of growth and it abruptly ceases as a stem emerges from the

soil. We only know, from an observation in the field, that the plant has germinated and is growing by the protrusion of its leaves. If we lift up a plant and wash away the clinging earth we see nothing but a mass of roots. All of these have arisen from the outgrowth of the root-eyes, and each leaf has a considerable number devoted to its use. The early protrusion of the leaves is a fundamental necessity of the plant, because, while the roots obtain salt and water from the soil, the leaves have, if anything, a more important part to play in the feeding of the young plant. It is mainly through them that the carbonic acid gas of the air is decomposed in the presence of sunlight, and the carbon of the plant obtained. It is, perhaps, needless to point out that, in sugar, the final product of the plant's activity, carbon, holds a predominant position. The amount of stored food material in the seed (or set, if grown from cuttings) is small, and it is of the first importance that the leaves formed by its help should emerge as early as possible so as to be in a position to produce more food, for only thus is the material rendered available for the rapid formation of the roots at the bases of the leaves. In the general growth of the plant the water and salts provided by the roots are combined with the carbon of the air to form the tissues of the rapidly succeeding organs.

Let us now pass on to the planted set. There is a good deal of water and other nutriment in the joints of the piece of buried cane. But this cannot be fully utilized by the buds until an abundant flow is available, both to assist in the chemical changes and to wash the dissolved food into the expanding shoot. For this reason the first stage of development here is the protrusion of the root-eyes found in the rings of tissue adjoining the buds. And these root-eyes of the set at once respond to the heavy irrigation usual in planting the sets. A mass of roots is thus formed which, it may be noted, being given off by the set above, form no part of the new plants produced from the germinating buds (Plate XIII, figs. 10–11). As soon as joints and leaves are developed in the bud, new rows of larger and more permanent roots grow out, and the old wiry roots of the planted set become effete (Plate XIII, figs. 11–12) and with the joints bearing them die and gradually decompose. Each plant arising from

a single bud soon becomes independent and separates itself from the parent set. The development of the shooting bud is, in fact, exactly similar now to the germ in the seed, but it is much more rapid. The plant produced from a set in two months from planting is about equal in height to a six months' seedling and is growing much more rapidly. The young stem of a germinating seed has but the thickness of a fine needle, and many joints must be formed, each thicker than its predecessor, before it becomes of appreciable size. A considerable amount of energy is used up in this increase in diameter, and a vertical section through a seedling stem has the form of an inverted cone with a sharp apex (Plate XIII, fig. 9). The bud on a set has enfolded, within its outer waterproof scales, a whole set of minute leaves with joints between them, all completely modelled and merely waiting for the flow of dissolved food to swell out; and the thickness of the stem at the base is somewhere near that of a lead pencil. There is still some measure of thickness to be attained, but, with the more advanced stage of the leaves and the send-off of the roots of the set, this takes very much less time. The cone of section of the stem has a very blunt apex.

Each bud of the set produces an independent plant. The bunch of canes in the field, which appear to form a single bush, in reality consists of several plants closely intertwined, the individual members of which are engaged in a strenuous struggle for space for their roots in the soil and for their leaves and branches in the air. As many members are unsuccessful in their struggle, the base of a cane plant is full of dead stems, leaves and buds, and the question naturally arises as to whether this mode of planting is an economical arrangement. Much of the strength of the plant is undoubtedly wasted in the production of organs which cannot fulfil their destiny, and an enormous number of canes of all ages habitually die before they are fully developed. One writer advocates the planting of single-bud sets, but we shall return to this subject on a future occasion, merely suggesting that the point is one in which experiments in the field are to be desired.

WHAT THE TUCUMÁN EXPERIMENT STATION HAS DONE FOR THE ARGENTINE SUGAR INDUSTRY.*

BY

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THE Tucumán Experiment Station was established by law in 1907 by a more than usually progressive Government, in order to study the causes of the constantly falling-off yields of cane in Tucumán cane fields. At the time of the law being passed it had been evident for several years that the cane was suffering either from some distinct disease or from a general degeneration—a phenomenon which had already occurred in several countries where this type of cane (Cheribon) was before mainly cultivated. The work of the new station, due to the necessity of finding competent *personnel* for work under the peculiar conditions of Tucumán—conditions most closely approximated by those of Louisiana—and of obtaining proper apparatus and securing sufficient data with which to begin serious investigational work, was started only in 1910. Experiments were begun along numerous lines of investigation, looking towards the improvement of the actual methods of cultivation as well as towards lowering its cost by the introduction of modern machinery with which to substitute the use of the expensive, though efficient, plough and spade work so much in vogue in this country. Irrigation and drainage investigations were also begun, and have given many valuable data. In a paper of this sort, however, it is impossible to discuss at any length the detailed experiments which have led to the improvement of the cultural methods of the province of

* Reprinted from *The International Sugar Journal*, October 1919.

Tucumán, so I shall, perforce, limit myself to the most striking and effective results which have by themselves revolutionized the industry of the province.

It was early seen that the native canes of the province were indeed suffering from a degeneration similar to that which had wiped out the same class of cane in several countries, notably Java, to give but one example. This degeneration manifested itself more and more clearly in the years 1910, 1911, and 1912, the exceptionally favourable climatic conditions of 1913 and 1914 dissipating to some extent the fears of Tucumán planters by once more presenting fair agricultural yields and splendid industrial recoveries. These yields, however, while comparatively good as far as comparison with recent years was concerned, demonstrated all the more clearly to us at the Experiment Station that the cane was really undergoing a process of physiological degeneration, else the yields under the exceptionally favourable conditions of those years should have been doubled in the field. These opinions and forebodings were justified when the unprecedentedly favourable seasons of 1913 and 1914 were succeeded by the record-breaking *unfavourable* years of 1915, 1916, 1917, and 1918, when Tucumán produced, instead of the 263,000 tons of sugar of 1914, considerably less than half of that amount in 1915, and less than 50,000 tons in 1916 and again in 1917. In 1918, although conditions were far worse than in any other year known, the effect of the new canes, of which we are now going to speak, had begun to be notably felt, the yield for that year being about double that of either of the two preceding ones. Indeed, had it not been for these canes in the crop of 1917 very little sugar would have been made even then, as the area of the native cane had been cut almost in half by 1916, and not more than 10 per cent. of what remained was worth while cultivating for 1917. The small amount of creole cane which is to-day cultivated in the province of Tucumán is attended to more on *sentimental* than on financial grounds.

Now let us see how this remarkable emergency has been met, and if the loss of the staple cane of the province is going to mean the abandonment of the industry, as at one time appeared to be the case.

It was immediately seen that all measures of improved cultivation and more efficient control of water, both for irrigation and drainage, would be well nigh useless unless the basis of the actual cane plantations could be changed by obtaining another variety of cane which, under the most difficult conditions of the Tucumán climate, would give more abundant yields than the native canes.

In 1910, some 126 varieties of cane were imported for trial under Tucumán conditions, directly from the Louisiana Experiment Station at Audabon Park, New Orleans, by the first Director of the Tucumán Station, Mr. R. E. Blouin, who had formerly been Director of the Louisiana Station. These canes represented varieties from almost all the well-known cane countries which were then being experimented with in Louisiana. In the same year, some 76 additional varieties were obtained from the Experiment Station in Campinas, Brazil, and we were fortunate enough to find already in the province six varieties which had been produced from seed in Java at the time that the famous *Sereh* disease had menaced the complete destruction of the Javanese canefields. These varieties had been imported in 1908, as a result of the law creating the Experiment Station, by the then Governor, Luis F. Nougues, one of the most progressive and far-seeing officials that Tucumán has ever had. Since 1910 some 15 or 20 of the more promising new varieties from different countries have been introduced each year and placed under experimentation, many of them giving us far superior results to those of the native canes. It was, however, from four of the six Java seedlings that I have just mentioned that we obtained the canes which have since practically supplanted the native and all other canes in Tucumán, and it is to these four varieties that I shall confine my remaining remarks.

In judging the new canes we had to seek the following points of superiority in comparison with the old ones :—(1) Greater tonnage, with (2) juices containing a higher percentage of crystallizable sugar. (3) Greater resistance to attacks of insects and cryptogamic disease. (4) Ability to stand lower temperature than the native canes. (5) The furnishing of more and better fuel in the shape of bagasse or fibre left after extraction of the juice of the cane. The

crop of 1911 showed up five of the Java canes, J. 36, J. 100, J. 139, J. 213, and J. 234, to be remarkably promising, although the J. 100 was left out of the race from the second year on and need not be considered more here, except that it stands as an example of the danger of jumping at conclusions from the results of one year of experiments under climatic conditions of but that one year. Several prominent cane men of the province were very much enthused with this cane, which is the largest and best appearing of all of them when well developed, and insisted on multiplying it on their plantations for two or three years, only to have to remove it at a considerable expense when it became affected with an even more vigorous degeneration, if the term *vigorous* may be employed in this connexion, than that from which the creole cane was suffering. In this first year the superiority of the Java canes was apparent more in the appearance and luxuriousness of growth than in actual yields, although J. 36 and J. 139 gave about 10 per cent. better yields than the native canes and J. 213 and J. 234, notably the latter, gave better chemical analyses of the juices. The conduct of these canes during crop also seemed to indicate superior resistance to frost attack.

In the crop of 1912, as first year ratoons, the four canes from Java more than doubled the yield per hectare obtained from the native canes under equal conditions, J. 213 giving ninety tons of cane and seven tons of sugar per hectare, against a little over 30 tons of cane and two and one-half tons of sugar for the best native yield. The J. 36 and the J. 139 each gave between 75 and 80 tons of cane per hectare, while the J. 234, producing about sixty tons of cane per hectare, had such a good sugar content in the juice that the sugar produced worked out at considerably more than twice that produced by native canes.

These striking results the second year, while not covering a sufficient range of climatic conditions to warrant us in recommending the canes unreservedly to the planters, did cause us to immediately start large-scale substation experiments near various factories, in order to obtain data under the varying conditions of the province, and, also, to be multiplying these promising canes in case time should

verify their value. It may be mentioned here that all the substation results in the following years confirmed the increasingly satisfactory results at the Central Station, and that we were thus enabled to multiply these canes to a considerable acreage by the time we were able definitely and unreservedly to recommend them.

The crop of 1912 also served definitely to establish the existence of superior frost-resisting qualities in these promising canes, which may be more of a physical than physiological phenomenon after all, due to their thick growth and heavy covering of leaves. We were also able to establish their increased resistance to the moth borer (*Diatræa saccharalis* var. *obliterellus*), due to the hardness of the rind as a result of its increased fibre content. This increased fibre content signifies, also, superiority in another of the five heads which we are investigating, that of furnishing more fuel in the shape of bagasse, since these canes all have from 20 to 30 per cent. more fibre content than the native canes.

A promising solution of the variety problem seemed well on the way and the splendid crop years of 1913 and 1914, while diminishing interest on the part of the planters in these new canes, served all the more to confirm their value and permitted us to increase the plantings in the strategic parts of the province without having to supply the canes in large quantities to the planters *before we were absolutely sure of our ground*, a most necessary caution in Experiment Station work, as premature recommendations often work serious evils and weaken the faith of the agriculturists in the very institutions to which they should accustom themselves to turn for assistance and advice. In these splendid years, 1913 and 1914, while fairly satisfactory yields were obtained from the native canes, *i.e.*, as compared with yields in the past decade, but seldom passing under the very best of conditions 30 tons of cane and sometimes less than three tons of sugar per hectare, *phenomenal* yields were obtained from the Java canes, the J. 213 producing in 1913 *over* 100 *tons of cane and* 11 *tons of sugar per hectare*, while the J. 30 persistently maintained yields above 70 tons of cane and seven tons of sugar. The J. 234 only about doubled the native yield of cane, but due to its superior chemical composition, consistently produced two and-a-half

times as much sugar per hectare. The J. 139 demonstrated itself again to be a late maturer but an extremely heavy yielder in the field, in this respect passing the J. 234.

In 1915 the climatic conditions were very unfavourable, and the native cane showed quickly that it had not, as many Tucumán planters had fondly persuaded themselves, regained its pristine vigour. The 1915 crop was considerably less than one-half that of the 1914 one, the yield per hectare being just a little over 50 per cent. that of 1914, but the chemical analysis, due to the early frosts, was very inferior. Nevertheless, not one of the four Java varieties under discussion gave us less than fifty tons per hectare, the J. 213, even under the unfavourable conditions of 1915, again passing the 80 ton mark.

A number of people in Tucumán, who had the previous year bemoaned the fact that high ocean freights caused by the movements of the German raiders on this coast at that time had prevented considerably larger exports of our surplus sugars to the European nations in order to clear the way for the huge crop which was to be made in 1915, now suddenly discovered that they had always opposed the idea of exportation and advised the accumulation of stocks of sugar under warrants from the Government. The outlook for the industry was decidedly bad, for the heavy frosts had done much damage to the stools of the already weakened native cane and the general situation was more serious than it had been for years.

At the Experiment Station and in the substations we had now had five years of experience with the new canes, under almost every climatic condition conceivable for Tucumán, and the results from these five years showed that the native canes had averaged 23 tons of cane and about two tons of sugar per hectare whereas the J. 213 had averaged almost 75 tons of cane and six and-a-half tons of sugar, and the J. 36 and J. 139, 65 and 60 tons of cane per hectare, respectively. The J. 234 had averaged, during the same period and under identical conditions, over fifty tons of cane per hectare, its uniformly high sugar content causing its production of sugar to reach almost five tons per annum. For the four Java varieties, the average annual yield during these five years was 62

tons of cane and well over five tons of sugar per hectare—considerably over double the native cane. Besides the question of cultural yield, we had been able to prove definite superiority on each of the five points we had placed as our objects at the beginning of these investigations. Results had been confirmed also, in later plantings on a large scale and all over the province in the substations. The time had come, therefore, for the Experiment Station to make definite recommendations of these canes for supplanting the native striped and purple ones. Early in 1915, an active propaganda was commenced and has been duly continued up to date, to induce the planters, large and small, to leave off the expensive cultivation of the degenerated native canes and supplant them as rapidly as possible with the vigorous, rapid growing Java ones, following the counsels of the Experiment Station officials as to the best of the Java varieties for their particular conditions of abundance or lack of irrigation water, exposure to frost, type of soil, etc., etc.

With the crop of 1915 a complete failure then, many of the more progressive planters of Tucumán at last put their prejudices and sentiments into their pockets, and began to plant the new canes more vigorously, many of them paying enormous prices for the seed cane to the more progressive men who already had large plantings for these varieties established. Some of these latter men made fortunes through their long-headedness, particularly those who were fortunate enough to have these canes planted in protected situations more or less free from the heavy frosts of the past four winters. When in 1916 the average yield of native cane dropped to only about eight tons per hectare, the prejudices against the foreign invaders in their cane fields almost entirely disappeared, and some 50,000 acres were laid down in these canes, the J. 213 predominating. The comparatively good development of these plantings in the unprecedentedly unfavourable seasons of 1916–17, *when all the native canes practically did not grow at all*, was the straw that broke the proverbial camel's back, and in 1917 everyone fell over themselves to secure seed of the Java varieties, paying almost any price asked, some sales being made at as high a price as 40 *pesos* per ton (over £3), which is more than twice the price paid

for cane for the mill even in the most critical periods of lack of supply (the actual price of cane in Tucumán to-day is less than £ 1 per ton).

It is most probable that another 60,000 acres were planted in 1917, which figure was very little added to in 1918, due to the frosts being so heavy and so early that extremely little good seed was available. Meanwhile the native cane had almost entirely disappeared, and with it a number of small cane planters have had to turn to other kinds of farming, as the enormous prices of Java seed-cane have been entirely beyond the poor man. It is probable that by the time the 1920 crop is ground the native canes will be looked upon as a curiosity should occasional specimens reach the mills. Such is the peaceful revolution which has taken place in the province of Tucumán, while the struggle was going on "to make the world safe for democracy."

We may safely say, then, that these investigations have saved the Tucumán industry from absolute bankruptcy, for no industry could resist the enormous losses which would have had to be sustained had Tucumán not had within its reach the salvation from the ridiculous yields to which its native canes had dropped, if she had not found her salvation *already waiting for her* when ruin was staring her in the face. It is probable that there is not a case in the history of Experiment Stations, and there are some remarkable chapters in that history, where one of the principal industries of a country has been so radically reconstructed and entirely saved in the short space of seven or eight years. An idea of the magnitude of the reconstruction may be gained from the fact that the "Ingenio Santa Ana," the largest place in the province, in fact the largest factory in South America, had for the crop of 1915 over six thousand hectares of cane (about fifteen thousand acres) not one stalk of which was of the Java varieties. In the two years of my connexion with that company we have entirely renovated these huge plantations with the Java varieties at a cost of over a million and a half dollars, and for the past crop we did not have a single stalk of native cane on all our large estate. In the province of Tucumán in general it may safely be predicted that in the crop of 1919 fully 90 per cent. of the cane which passes through the mills will be of the Java varieties.

There is a very common tendency to consider the work of the Experiment Station as something extremely and luxuriously theoretical, as something interesting but of slight practical application. The work of the young Tucumán Experiment Station may well be used as evidence in refutation of this charge. Let us see for a moment what this one series of investigations may mean in dollars and cents in saving expenditure for the Tucumán planters. And the figures here given are not theoretical ones, but are based on the *actual costs* from thousands of acres of the two classes of cane from the time of planting to that of harvest. It is generally conceded that the native cane, year in and year out, costs just about one hundred *pesos* per hectare (about £4 sterling per acre) in actual cultivation, in fact this has always been the amount universally advanced by the factories to their colonists and *caneres*. The average yield for the native cane, before the last series of disastrous years, has been about twenty tons per hectare. That means, therefore, that the cost of cultivation of the native cane per ton is just five *pesos*. Let us see how this compares with the cost of cultivation of the Java varieties, which are quicker growing and, hence, need less weeding and general cultivation and which yield from twice to four times as much as the native cane. Let us take as a conservative figure only twice the yield of the native cane from these varieties and assume that we will spend 80 per cent. as much in cultivation per hectare; a figure which will never be realized as the Java canes can be cultivated at a much lower rate. This means, then, reduced to cost per ton, that the Java canes cost us for cultivation only two *pesos*, whereas we have been spending five on the native. The Tucumán planters, then, are to-day saving in cost of cultivation at *least three pesos on every* ton of cane they deliver to the *factories*! When the plantations are normalized, which will be for the crop of 1920, Tucumán will grind about 2.000,000 tons of cane annually.

Will not the Tucumán Experiment Station have paid a splendid dividend to its stockholders. the cane and sugar men of Tucumán, when, *as the result of only one series* of experiments, it contributes to the little province a saving in the cost of cultivation of its principal

crop of a round six million *pesos* per year (about £500,000)? Is it not likely that these results will place the province of Tucumán within a few years in a position which will permit her to enormously increase her production and compete under more favourable terms with other countries having vastly superior climatic and geographical conditions?

THE WORLD'S SUGAR SUPPLIES.*

IN view of the fact that at the close of the year the British Sugar Commission ends its work, and that prices will afterwards be governed by open market conditions, more than usual interest attaches to the reports of the present crop and the estimates of the world's supplies. Indications point to there being plenty of sugar in the world to meet normal requirements, though he would, indeed, be a rash person who went so far as to prophesy a return to pre-war values, or even a substantial reduction in the prices which have steadily risen during the past five years.

The United Kingdom is one of the greatest sugar-consuming countries, and, unlike the majority of others, is entirely dependent upon imports for its supplies. Before the war those imports of cane and beet, refined and unrefined, were rapidly approaching the round figure of two million tons a year. This approximately represents a consumption which was exceeded in bulk only by the United States and British India, with Germany and Russia occupying fourth and fifth positions. The average annual consumption in the five years' period 1908–13 for the world is estimated at 15,850,000 tons, the principal consuming countries being America 3,400,000 tons, British India 2,830,000 tons, United Kingdom 1,800,000 tons, Germany 1,460,000 tons, Russia 1,180,000 tons, Austria-Hungary 680,000 tons, and France 643,000 tons. On the basis of population, the United Kingdom was an easy first in the average consumption per head, with America next. A curious fact is that while the world's supplies averaged nearly 16 million tons a year, the exportable surplus of producing countries averaged only $5\frac{1}{3}$ million tons, of which the United States absorbed 50 per

* Reprinted from *The Economist*, dated 1st November, 1919.

cent., Great Britain 34 per cent., and British India 11 per cent. Notwithstanding that India produced more sugar than any other country, it was not self-supporting, having to import 20 per cent. of requirements, principally from Mauritius, Java, and Austria-Hungary. On the other hand, the United States, with great resources, produced only 23 per cent. of requirements, and imported very largely from the West Indies. Of European countries, Germany, Austria-Hungary, Russia, France and Holland all produced a varying surplus for export.

Before the war the United Kingdom's requirements were supplied to the extent of 96 per cent. from foreign countries, and 4 per cent. from British possessions, fully half of the former being derived from Germany, and a fifth from Austria-Hungary. In 1913, for instance, our net imports of sugar were 1,968,760 tons, of which Germany sent 936,900 tons and Austria-Hungary 358,922 tons—in all, 1,295,822 tons, or just on 66 per cent. of the total net imports. It will be readily gathered that when war cut off these sources of supply the United Kingdom found itself in a very tight position, and had to turn to other quarters to supplement the 34 per cent. left. Cuba, which in pre-war years sent us about 200,000 tons, was appealed to, and increased her export to the United Kingdom to as much as 700,000 tons in 1917, while the British West Indies, Peru and America were all drawn upon for larger quantities. In the circumstances of a world shortage, due principally to the exclusion of German and Austrian sugar, and the difficulties attaching to overseas transport, it could not be expected that normal supplies could be assured. Great Britain, nevertheless, did very well, and managed to import 70 to 75 per cent. of the quantity she might otherwise have imported, as the following returns of net imports will show :—

	Tons	C. I. F. values £
1913 .. .	2,969,255	23,066,621
1914	1,984,074	32,013,077
1915	1,480,263	31,862,563
1916	1,529,160	37,271,340
1917	1,386,793	36,685,807
1918	1,606,109	34,368.147

By way of illustrating the increase in value, it may be noted that the average cost per cwt. in 1913 was 11*s*. 8*d*.; in 1918 it had advanced to 26*s*. 3*d*. per cwt. Imports to the United Kingdom this year so far show a fair improvement on the previous two years, total to hand in the eight months January–August being returned at 1,123,107 tons, against 908,013 tons and 960,600 tons in the corresponding periods of 1917 and 1918, respectively. Should the remaining four months of the year maintain the same level, we may expect to receive about 1,700,000 tons, or 400,000 tons more than in 1918. Incidentally, it may be said that less than 20,000 tons of this year's imports came from Europe. Cuba, however, heads the list with, in round figures, over 400,000 tons, Java following with 225,000 tons, the United States 150,000 tons, Mauritius 135,000 tons, and the West Indies 92,000 tons.

With regard to future supplies, the outlook is by no means altogether unsatisfactory, the estimates of the present world's crop being about half a million tons above the pre-war average, but about the same quantity below 1917 yield, and 800,000 tons behind last year. In a table printed in the "Commerce Monthly," of New York, for September, the average production of the principal sugar-producing countries in the five years preceding the war, the output of 1917 and 1918, and the estimated yield of the 1919 crop, are given as under in short tons:—

Country	1909-13 (5-year average)	Per cent. of total	1917	1918	*1919
	Tons		Tons	Tons	Tons
British India	2,520,587	14	3,055,360	3,708,320	2,617,000
Germany	2,385,551	14	1,796,390	1,759,047	1,581,000
Cuba	2,050,843	12	3,386,566	3,859,613	4,480,000
Austria-Hungary	1,586,815	9	1,057,840	748,440	784,000
Russia	1,572,136	9	1,480,192	1,172,010	784,000
Java	1,454,540	8	1,787,715	2,005,992	1,870,000
United States	881,734	5	1,133,626	1,010,660	1,040,000
France	751,498	4	206,294	224,297	123,000
Hawaii	554,096	3	614,571	576,839	582,000
Porto Rico	348,456	2	502,395	453,795	420,000
Formosa and Japan ..	255,249	1	488,349	445,332	466,000
Other countries	3,379,013	19	3,477,234	3,468,565	3,565,000
Total ..	17,740,518	100	19,026,532	19,412,910	18,312,000

* Estimated.

This table only is in short tons; to translate into long tons, deduct 10·7 per cent., which in the case of the aggregates would give an estimated 1919 production of 16,350,000 long tons, against 17,332,000 tons actual in 1918, and 17,000,000 tons in 1917, and comparing with a pre-war average of 15,850,000 tons. It will be seen that Cuba now leads the way in sugar production, the present crop being equal to 25 per cent. of the world's supply, and at least 100 per cent. more than her pre-war production. Before the war British India and Germany were first and second, respectively, with Cuba third. The dislocation occasioned by the war, however, was responsible for great changes. The cutting off of Germany and Austria-Hungary had the effect of stimulating production in other quarters. British India increased her sugar production in 1918 by 50 per cent. over her pre-war average, and had surplus for export. The present crop appears to have fallen back to about the old level, and if it realizes no more than the estimate, she will have need to import half-a-million tons to meet consumptive requirements. The estimates of the production of Germany and Austria-Hungary approximate to normal home consumption, so that it seems unlikely that either of these countries, upon whose surplus we relied to so large an extent, will have anything of the present crop to export, unless their own peoples deny themselves. The shortage in these two countries represents a difference of 1,460,000 tons in the world's supply. Russia's crop is put down at half pre-war average, and equal to about 50 per cent. of Russia's normal consumption, while France, which previously was self-supplying and had a small surplus of 30,000 to 40,000 tons for export, will have to import about 600,000 tons. In other words, Europe, including the United Kingdom, will require over six million tons of sugar and will produce only half that quantity. The falling off in European production is, however, offset by the greater outturn of Cuba, as already noted, by Java, the United States, Japan, and others who have increased their crops. It may be added that the Royal Commission on Sugar co-operating with the American Food Administration, formed an International Sugar Committee, and arranged to buy the entire Cuban crops of 1917-18 and 1918-19, the United States taking about

two-thirds of the production, and the Royal Commission the remaining third.

The extent to which sugar from beet has played a part in the world's sugar supplies may be seen in the fact that in the five-year period preceding the war it amounted to 45 per cent.; this year it is estimated at only 27 per cent. Owing to our drawing so largely upon Germany and Austria-Hungary, our nearest sources of supply, about two-thirds of the sugar consumed in the United Kingdom in other days was beet sugar. Latterly, owing to the change in the sources of supply, it has been preponderatingly cane sugar, the production of which by places within the British Empire increased from 3,275,500 tons in 1913-14 to 4,384,100 tons in 1917-18, when it formed one-fourth of the world's supply. Germany, her export market gone, had, according to the President of the German Industrial Sugar Users, an area under beet in 1918 of only 367,000 hectares (hectare equals 2·47 acres), as against 569,000 hectares in 1914, or roughly a decrease of 35 per cent. In Austria-Hungary the area under beet decreased 50 per cent. Europe is, of course, the great sugar beet-growing centre, and the future of its crops and their influence on sugar production elsewhere will be followed with the keenest interest. Will the industry revive in Germany and Austria-Hungary and assume pre-war extent, or will the dislocation which the war occasioned, and the development of cane sugar-growing prove too heavy a handicap? In other words, will beet sugar successfully compete with cane sugar? Recently it was stated at a meeting of the British Society of the Chemical Industries that the British Empire, with about 3,500,000 acres under sugar mostly cane, produced less than Germany and Austria-Hungary combined from less than half that area under beet. Of course, Germany, since it wrested the lead from France after the Franco-German war, had made great progress in improving the sugar content of the beetroot, which in the early days of the industry was only 6 to 8 per cent. While it is said the roots of the 1909 harvest contained an average of 17·63 per cent.

Efforts have been made in this country to induce farmers to grow beet for sugar, but in view of the cheapness of imported sugar

it has not been demonstrated to be a sound commercial proposition. Apparently the United Kingdom has a long way to go before it can establish a successful beet sugar industry. A regular supply of roots and co-operation between grower and manufacturer would appear to be essential, and not less important the cultivation of the beet to ensure the highest standard of quality. Investigation of 375 samples of sugar beet grown in the United Kingdom proved them to be in composition and purity above the average of those grown on the Continent, but it was reported that in other respects British-grown roots were so defective that it would be impossible to deal with them in a factory. The report of the society added that "until greater attention is bestowed on the culture of sugar beet it cannot be asserted that sugar beet can be grown in the United Kingdom equal to those furnished on the Continent."

Sweden, by the way, is successfully cultivating sugar beet, the area under beet this year being 36,034 hectares, or 14 per cent. greater than in 1918. With an average harvest it is anticipated that this year's production will suffice to meet most of Sweden's needs.

BOTANY AND ITS ECONOMIC APPLICATIONS IN THE EMPIRE.

At the last meeting of the British Association at Bournemouth, Sir Daniel Morris, President of the Section of Botany, in the course of his opening address,* said :—

There can be no doubt that not only in the West Indies but also in all parts of the Empire, " Enlightenment as to the objects, methods, and conditions of scientific research is proceeding at a rapid rate." Perhaps the most interesting feature of the progress made is in connection with the application of the laws of heredity to the improvement of such highly important crops as sugar, wheat, and cotton. The problems associated with these involve both scientific and economic considerations. As regards the scientific side, it is fortunate that with the beginning of the twentieth century came the rediscovery of Mendel's facts and the stimulating energy of the genetic school which has brought us an entirely new point of view in regard to the increased production of field crops.

Great importance is attached to the improvement of the sugar-cane, as the prosperity of many of our possessions depends upon it. Further, the requirements of this country approach something like 2,000,000 tons per annum. The sugarcane, although its origin is unknown, has been cultivated in tropical and sub-tropical countries from remote ages. Up to a recent date its propagation was purely vegetative, as it was supposed to have lost the power of producing mature seed.

Sugarcane seedlings were observed at Barbados in 1858, but it was only in 1888 that Bovell and Harrison were in a position to utilize the discovery and obtain thousands of self-sown seedlings for experimental purposes. Similar seedlings were also available in Java about the same time. As about this period the standard

* Reprinted from the abridged report in *Nature*, dated 11th December, 1919.

canes in sugar-growing countries were showing signs of being severely attacked by disease, the discovery of seedlings was a fortunate circumstance. In fact, in some cases it may be regarded as having probably saved the industry. In British Guiana it is reported that in the crop of 1918 seedling canes occupied 83 per cent. of the total area under canes. Similar results have been obtained at Barbados, where Bovell has continued since 1888 raising canes of great merit.

In India there is probably a larger area under sugarcane than in any other country. Its production of sugar is more than 2,000,000 tons. The larger proportion of this consists of a low-grade quality known as *jaggery* or *gur*. Palm-sugar is also produced to the extent of 500,000 tons. Speaking generally, the sugar industry in India is not in a satisfactory condition. In spite of the enormous area under cultivation, India is obliged to increase its considerable imports of sugar from Java and other countries. To obviate this, urgent steps are being taken to improve the character of the canes and establish varieties adapted to local conditions and the circumstances of the sugar-growers.

In the considerable literature of sugarcane-breeding in India Barber has brought together a vast amount of information of singular interest and value. In the few years that have elapsed since he has been in charge of the Coimbatore Research Station he has laid the foundation of lines of inquiry that cannot fail to prove of great value in the permanent improvement of the sugar industry in India.

In his presidential address in 1898 Sir William Crookes stated that the prime factor in wheat production was a sufficient supply of nitrogen. As the supply was then showing signs of exhaustion he warned wheat-growers of the peril awaiting them. Sir R. H. Rew has now shown that, thanks to the chemist, who came to the rescue, there is practically no limit to the resources of nitrogen. During recent years Biffen, by his successful investigations on Mendelian lines at the Plant Breeding Institute at Cambridge, has shown that the characteristics distinguishing the numerous wheats can be traced, and the building up of a fresh combination of these

characters was possible on practical lines. As the losses caused by disease were so serious, sometimes running to millions of quarters annually, Biffen devoted special attention to the possibility of breeding rust-resisting varieties. He found that the power of resisting the attacks of yellow rust, for instance, was an inheritable character. By crossing Gurka, a Russian disease-resisting wheat, with Square Head's Master, one of the most widely cultivated wheats in this country, Biffen eventually produced Little Joss, which, after trials extending over a period of several years, is said to yield four bushels per acre more than any other variety. Further, it possesses distinct disease-resisting qualities.

Another of Biffen's new wheats is Yeoman. This was raised in order to produce what are known as strong wheats. These are in great demand in this country, as they produce a flour which is much superior for baking purposes to the flour of English wheat. In pre-war days Canadian strong wheats commanded in the market 5*s*. more per quarter than the best English wheat. Yeoman not only possesses the superior quality of Canadian wheat, but combines with it the high-yielding character of certain English wheats.

A well-authenticated report, supplemented with full details, of the value of Yeoman as a field crop, was lately published (*Journ. Bd. Agric.*, Vol. XXV, 1161). It was cultivated under normal conditions, but without artificial manure, on three fields on a large farm near Wye, Kent. The cropped area was a little more than twenty-seven acres. The total yield was 2,072 bushels, or an average of about seventy-seven bushels per acre. One field, previously under beet, comprising three acres, two rods and eight poles, yielded 349 bushels, or an average of eighty-six bushels per acre. These results may be compared with thirty-two bushels, the average yield of wheat in this country.

A most desirable improvement in wheat-growing in this country is to obtain a spring wheat combining early maturity with a yield approaching that of winter wheat. The establishment of a National Institute of Agricultural Botany for the further development of plant-breeding and the distribution of pure seed may be regarded as essential to the welfare and safety of the nation.

Wheat-growing is a very important industry in India. It was estimated in 1906-7 that 29,000,000 acres were under cultivation in wheat with a yield of nearly 9,000,000 tons. Of this 90 per cent. was consumed in India. A botanical survey of the Indian wheats was undertaken by the economic botanists at the Imperial Research Institute at Pusa in 1910. In the following years, by the application of modern methods of selection and hybridization high-grain qualities were successfully combined with high-yielding power, rust resistance, and stiff straw, so that wheats were produced which gave upwards of forty-one bushels per acre.

Among the best of the new varieties are Pusa 4 and Pusa 12. Owing to an organized system of distribution of seed, it is estimated that the area under Pusa 12 during the last wheat season (1918-19) was about 400,000 acres. The area under Pusa 4 was about 100,000 acres.

The important work carried on at Pusa by Howard and his accomplished wife has followed closely on the methods found so successful at Cambridge. It is interesting to note that in obtaining new kinds by hybridization between Indian wheats and rust-resisting forms in Northern Europe a difficulty in regard to flowering at different periods was overcome by sending the Indian parents at Cambridge for spring sowing and by carrying out the actual crossing with Biffen's new hybrids in England. From the crosses thus obtained Howard reports that a wide range of wheats has been evolved likely to prove superior to Pusa 4 and Pusa 12.

The admirable work done by Biffen at Cambridge and the Howards in India clearly demonstrates the value of thorough acquaintance with pure botany as a qualification for grappling with questions of economic importance.

In reviewing the gain to Indian wheat-growers the Director of the Agricultural Research Institute has recently stated that, in view of the favour with which the new wheats have been received and the cordial co-operation of provincial organizations, "it is a modest estimate to assume that in course of a very few years the area under Pusa wheats will reach 5,000,000 acres. This means an increase, in the near future, in the value of the agricultural produce

of India, in one crop only of 75 lakhs of rupees or £5,000,000 sterling."

As in wheat, so in cotton, this country is almost entirely dependent on foreign supplies. The uneasiness caused by the excessive dependence of the great Lancashire cotton industry, with exports of the annual value of more than £100,000,000 sterling, on supplies from abroad, and the occasional shortage, have led to general action being taken to encourage the more extensive growth of cotton within the Empire. Next to the United States, which in some years has supplied seven-tenths of our imports, India comes second, but the East Indian cotton is not well suited to the requirements of the English spinner. Egypt, as the third producing country, supplies cotton of great strength and fineness.

The most valuable of all cottons is that known as Sea Island cotton, owing to its introduction and successful cultivation on the coastal areas in South Carolina, Georgia, and Florida. It is interesting to report that in recent years Sea Island cotton has been introduced back again to the West Indies, which was probably its original home. This was effected by the Imperial Department of Agriculture in the West Indies in 1902, when a pure strain of seed raised from plants immune to wilt disease was obtained in quantity from James Island. This ensured that the industry from the first was placed on a firm basis, and, with the hearty co-operation of the planters, an important West Indian cotton industry was successfully established. For some years the West Indian cotton has obtained a higher price than the corresponding grades of cotton from the Sea Islands themselves. The fine spinners in Lancashire are now practically independent for their supplies of this cotton from the United States. Further, it is not improbable that, owing to the serious attacks of the Mexican boll weevil on cotton plants in South Carolina and Georgia, the West Indies may become the only source of supply of fine Sea Island cotton. The results so far attained may be realized from the fact that the West Indies in recent years has reached a total of £2,000,000 sterling. The general conditions in the West Indian islands, owing to their small size and comparative isolation, should enable them to maintain a high purity of cotton. Harland,

whose services in the West Indies have been provided by a grant from the Imperial Department of Scientific and Industrial Research, has in hand important investigations with the view of placing the work of cotton selection and breeding on scientific lines. He has shown that the yield of lint per acre depends on a number of factors of a morphological and physiological character. In a general way it may be said that the yield is dependent on the climatic conditions, so an effort is being made to produce varieties which will interact with the environmental conditions to the best advantage. Although Harland's work so far is of a preliminary character, he is able to suggest the conclusion that, following certain lines of selection and breeding and bearing in mind the relative importance of lint index and lint percentage, it is possible to isolate a strain of Sea Island cotton with a weight of lint per boll 31 per cent. greater than that of the ordinary sorts in cultivation.

As already mentioned, India is the second largest producer of cotton. In 1906-07 it was estimated that there were about 20,000,000 acres under cotton with a production of nearly 5,000,000 bales. It is unfortunate that the quality of East Indian cotton is not high, in spite of the considerable efforts made in recent years to improve it.

Leake's research work in the United Provinces, carried on for many years, is regarded as probably the most complete yet attempted with cotton in India. A variety known as K. 22 has been widely distributed, and the produce in 1916 sold at 31 rupees per maund when local cotton was 25 rupees. Further, the ginning percentage has been raised from 33 to about 40, while the lint is of superior quality.

Leake has also been successful in raising an early-flowering form of cotton on Mendelian lines. The new form differed from ordinary cotton cultivated in the United Provinces in that it assumed a sympodial instead of a monopodial habit. It not only yielded cotton of high quality, but was found by its early-flowering habit to suit the special conditions of the United Provinces.

As Egyptian cotton comes next to Sea Island cotton in quality, it may be useful to refer to what has been done, or attempted to be

done, on scientific lines to safeguard the industry. Its importance may be gathered from the fact that the area under cultivation is between 1,500,000 and 2,000,000 acres. Balls has fully reviewed the scientific and other problems that had to be solved in placing the industry on a satisfactory footing. According to Balls, the high-water mark of Egyptian cotton-growing was from 1895 to 1899. Since that time, although the actual area under cotton has been increased by 600,000 acres, the benefit measured in terms of cotton alone has been small. It is probable that the attacks of the pink boll-worm and other pests may have affected the results, but Balls and his colleagues drew the conclusion that "the falling off in yield was due to a rise in the level of the subsoil water or water table of the country brought about by the extension of the irrigation system during the past decade." The roots of the cotton plant were thus adversely affected at a critical period of growth. This recalls what Howard discovered: that one of the causes of the wilt disease in indigo in India was the destruction of the fine roots and nodules during heavy monsoon rains.

Probably the most remarkable instance on record of the successful combination of science and enterprise in the tropics is the establishment of a cacao-growing industry in the Colony of the Gold Coast, West Africa. Thirty years ago no cacao of any kind was produced on the coast. Owing, however, to the foresight of the then Governor (Sir William Brandford Griffith), who sought the powerful aid of Kew, cacao-growing was started in a small way among the Negro peasantry with eventually extraordinary results. After selecting the locality for the experiments, seeds and plants were obtained through Kew, and a trained man was placed in charge (*Kew Bull.*, 1891, p. 169; 1895, p. 11). The first exports in 1891 amounted to a value of £4 only. So rapid was the development of the industry that ten years later the exports reached a value of £43,000. By this time both the people and the Government had begun to realize the possibilities of the situation, and systematic steps were taken to organize under scientific control a staff of travelling agricultural instructors to advise and assist the cultivators in dealing with fungoid and insect pests and improving the

quality of the produce. In 1911 the exports had increased nearly fourfold and reached a total value of £1,613,000, while in 1916 what may possibly be regarded as the maximum exports were of the value of £3,847,720.

It should be borne in mind that this Gold Coast cacao industry, now one of the largest in the world, has been called into being and developed entirely by the agency of unskilled Negro labour, and on small plots from one to five or ten acres in extent. The controlling factors were, first, the selection of suitable land for cacao-growing; next, the selection and supply of seeds and plants of varieties adapted to local conditions; and, lastly, the advice and assistance of trained Europeans backed by the resources of science.

Coming nearer home, Henry, well known from his association with Elwes in the production of "The Trees of Great Britain and Ireland," by historical research and experiment, has established the fact that many fast-growing trees in cultivation, such as the Lucombe Oak, Common Lime, Cricket-bat Willow, Black Italian Poplar, Huntingdon Elm, etc., are natural hybrids. It was of high scientific importance to discover the origin of these valuable trees. Further, by artificial pollination, Henry has succeeded in raising new hybrids which display the extraordinary vigour characteristic of the first-generation cross. Perhaps the most notable so far is a new hybrid poplar (*Populus generosa*) which makes the strongest shoots of all poplars. It is claimed in the case of hybrid trees that "it is possible to produce much greater bulk of timber in a given time." The common belief that quickly grown timbers are of inferior quality is said not to hold good in respect of any quality in ash, oak, and walnut. In fact, according to Dawson, "with oak, ash, and walnut the quicker their growth the better their quality in every way. They are more durable, more elastic, and less difficult to work" ("Science and the Nation," p. 138). It is further claimed that by hybridizing it may be possible to produce disease-resisting varieties and varieties carrying with them other desirable characteristics.

In the tropics breeding experiments in the case of India-rubber trees are likely to prove of great value. In the meantime, selection

of seed from the best trees is being carefully carried out in the hope of increasing the general yield of the plantations. In Java the proportion of alkaloids in the bark of introduced cinchona trees (yielding quinine) has nearly doubled by careful selection on these lines.

Plant-breeding experiments with India-rubber trees have already been attempted, but they are not likely to be of much value if they are confined to empirical and haphazard lines. Work of this kind must be lengthy and complex, but it is absolutely essential to ensure the safety of an industry which is estimated to be of the annual value in the Middle East of about £50,000,000 sterling. The Agricultural Department in Ceylon, which is fully alive to the fundamental importance of the selection and breeding of India-rubber trees, has already taken some action in the matter.

Another investigation in hand is to determine whether the latex-yielding quality of *Hevea* trees can be associated with any definite botanical characters and to what extent such characters are transmissible. Twenty trees of the same age growing in a four-acre block have been selected for differences in leaf and bark characters. These are all tapped on the same system, and the yield of rubber from each tree is recorded separately for each tapping (*Kew Bulletin*, 1917, p. 118).

The value of these and other experiments of a like nature may be realized when, according to Varnet, quoted by Johnson, the yield of rubber from different trees of *Hevea* growing under similar conditions in the same plantation may vary as regards volume of latex from 4 to 48, and in percentage of weight of dry rubber from 1·286 to 14·164 (*Journ. d'Agric. Tropicale*, 1907).

Bateson a few years ago expressed the opinion that nowhere is the need for wide views of our problems more evident than in the study of plant diseases. Biffen and others have shown that under certain conditions the quality inherent in some varieties to resist disease may be utilized to great advantage. The national importance of such work is impressed upon us by the enormous losses sustained every year by rust in wheat, mould in hops, and the widespread disease of potatoes. One of the most striking instances

in recent times was the destruction of the valuable coffee plantations in Ceylon. The industry, an exceptionally valuable one, was wiped out in a comparatively few years by the coffee-leaf disease (*Hemileia vastatrix*). In the light of our present knowledge it is not improbable that this disease may have been checked by seed selection or by raising an immune race of plants or, more probably, as suggested by Armstrong, by regulating the use of essentially nitrogenous manures, which are known in some cases to intensify the attacks of fungoid pests, and substituting the use of phosphates. As illustrating the occurrence of an incidental result arising from a purely scientific investigation, mention may be made of the discovery of a remarkably tall strain of flax at the John Innes Institution. This, if capable of being established on pure lines, may prove of economic value. It is a hopeful sign that the appreciation of the work done at this institution, under the stimulating energy of Bateson, is increasing day by day. We may mention the great success which is attending the establishment of a school of technical education and research by the Royal Horticultural Society at Wisely. This is maintained by liberal funds, and by means of its well-equipped laboratories and extensive trial grounds it offers unique facilities for solving problems of great value as affecting the future of British horticulture. In sympathy with the work at Wisely, private firms are also setting up laboratories of their own and employing men of high standing so that a just balance may be maintained between science and practice. The progress made in the elucidation of problems in tropical plant pathology shows the necessity not only for well-trained and experienced mycologists and entomologists, but also for the correlation and combination of knowledge gained in their several lines of study. It is suggested that research work should be organized on the broadest possible lines, and combine the biological services of the whole Empire. We have a first step in this direction in the Imperial Bureau of Entomology, with its headquarters at the British Museum. Those acquainted with the efficient work done by this bureau and the excellent publications issued by it will very heartily welcome the establishment of the proposed Imperial Bureau of Mycology to carry on work on similar lines.

Notes

HALF-BRED AYRSHIRE-MONTGOMERY CATTLE AT PESHAWAR.

In January 1917, two half-bred Ayrshire-Montgomery bull-calves were placed with the Awankari herd at the Peshawar Agricultural Station, to observe their thriftiness in general, and their resistance to diseases which are never long absent from the neighbourhood of the farm. A third calf was at the same time given to a neighbour in a village near by, there to be observed, whilst taking his chance of life with the village cattle. The half-bred animals were brought up on the pail. The pair on the farm were fed whole milk, with a little concentrated food in season. Reared in this way they of course cost more to bring up than they were likely to realize as work-bullocks, but they grew into big, blocky, strong-limbed, and quite exceptionally good handsome bulls. They were never sick or sorry until they attained the age of two years. Then rinderpest carried off No. 1, when that disease was abroad in the land. But happily, no Awankari or working bullock in the Tarnab herd of about 60 animals was attacked. The cross-bred No. 1 was the first to succumb to the disease. No. 2 was not affected when his stable companion died. The entire herd was inoculated when cross-bred No. 1 was seen to be ailing and the usual precautions were taken to prevent the spread of the disease when the case was diagnosed.

Now, four months after the death of No. 1, No. 2 has "foot-and-mouth." The trouble is prevailing in the neighbourhood, but thus far no Awankari or working bullock is affected. So the half-bred is banned the herd, and soon he will go to the butcher. An animal that is peculiarly liable to disease is a danger to all the herd.

No. 3 early saw the desolation of rinderpest. When he was less than three months of age, the writer observed him, and in sympathy rubbed his poll, as he awaited inoculation amidst many cattle in the village, a village where, the week before, 40 head succumbed to rinderpest. He came through that trial unaffected. And although foot-and-mouth is in the villages off-and-on nearly always, he escaped that also without in any way foregoing his freedom or the companionship of reputedly hardier kine.

But he is dead now. His owner became ashamed of him, for he was a dwarf. He was hardly more than half the size and weight of his half-brothers on the farm who were much of his age, but who had the good fortune to be brought up on whole milk and good Agricultural Station rations. He was not a pinched starved dwarf. He was a sleek little "Tom Thumb."

So ends the small trial of half-bred cattle at Tarnab.

Knowing the heavy toll rinderpest and other diseases have taken from imported bulls and their half-bred progeny in India, and bearing in mind that foot-and-mouth especially is never long absent from the villages, more than ever the utmost will be done at Tarnab to raise the milk yield of the Awankaris by *selection*, rather than *by an infusion of foreign blood.*

The work bullock whose upbringing costs Rs. 150 or more must not be more than usually prone to suffer from the diseases that so frequently visit the villages.

Regarding the thriftiness of cross-breds and Awankaris respectively, on nearly level terms they did equally well. Up to the age of two years, which was the period of the trial, the Awankaris, age for age, were as heavy as, and far more handsome and active than, the cross-breds (Plate XIV).

But the loss of the two cross-breds at Tarnab is regretted. They got a lot of kind handling and Plate XIV shows that they responded to good fare and kindness.

The trial was of course *quite* a small one. But soon, perhaps, records of the progress of the big herds of half-bred cattle that are now in India will be published. [W. ROBERTSON BROWN.]

PLATE XIV.

Awankari. Ayrshire-Montgomery.

THE BRITISH EMPIRE SUGAR RESEARCH ASSOCIATION.

We have received the following for publication:—

The need for a British Sugar Research Association has so long been felt by sugar planters, refiners and all those manufacturing firms directly and indirectly concerned with sugar, that the formation of such an association as has now come into being will be welcomed.

With the assistance and support of the Government Department of Industrial and Scientific Research, a strong association has now been formed, whose memorandum and articles of association, and prospectus, have received the approval of that department, as well as that of the Board of Trade. On 30th May, 1919, this association was registered under the presidency of Sir George Beilby, who is a member of the Advisory Council of the Government Department of Industrial and Scientific Research. The Vice-Presidents are the following distinguished gentlemen:—the Rt. Hon. Lord Bledisloe of Lydney, K.B.E.; Sir Daniel Morris, K.C.M.G., D.C.L., D.Sc., LL.D.; Sir Edward Rosling; Professor E. J. Russell, O.B.E., D.Sc., F.R.S.; Professor W. Bateson, D.Sc., F.R.S.; Professor J. Bretland Farmer, D.Sc., M.A., F.R.S.; and Mr. Edward Saunders.

The gentlemen elected to the Council represent every branch of the sugar industry throughout the Empire.

The aim of the association is to establish, in co-operation with the Government Department of Scientific and Industrial Research, an empire scheme for the scientific investigation, either by its own officers, or by universities, technical schools and other institutions, of the problems arising in the sugar industry, and to encourage and improve the technical education of persons who are or may be engaged in the industry.

The association is inviting all those who are engaged in any branch of the sugar industry within the empire to become members, and thus become eligible for benefits resulting from the scientific investigations it will carry out.

While it may be admitted that research work has always been proceeding in scattered localities of the empire, where cane and beet

are grown, and also in England where sugar is refined, as well as in factories where sugar is an ingredient for the manufacture of the finished article, such research is carried out by the factory's chemist, who works continually for the improvement of sugar manufacture. Such improvements, however, often remain only half investigated, owing to the time given to routine work, which is the main occupation of the factory chemist. There are few factories who can employ a highly skilled chemist mainly for research work, therefore the necessity for an organized association where research will be carried out by the best brains, for the general benefit of the empire sugar industry, is felt daily more and more.

The scope of the work to be done by the association will include the investigation of problems arising in all branches of the sugar industry, including the improvement of the sugarcane, sugar beet, the various methods of extracting the sweetening matter from cane and beet, the various processes of refining, and the best methods for the use of sugar employed by manufacturers using sugar as one of their raw materials, as well as the discovery of the best uses of the after-products of both factory and refinery.

In order to make the research work of the association of the greatest possible utility to the industry, power has been taken, not only to encourage the training of research workers, but also to improve the technical education of persons engaged, or likely to be engaged, in all branches of the sugar industry.

A survey is being made of the field of research which is likely to be beneficial to the industry, and it is hoped that members of the association will be willing to assist in the framing of a thoroughly comprehensive scheme, by making suggestions relating to that part of the industry with which they are intimately acquainted.

It is also proposed to establish a bureau of information for the sugar and allied trades industries, to which any member of the association can apply for assistance in the technical and other difficulties which he may encounter in his business.

By means of its various activities as an association for sugar research, a bureau of information, and a centre for the furtherance

of technical education, it is hoped that the British Empire Sugar Research Association will exercise a far-reaching and beneficial influence on the future welfare of this ancient and important industry.

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THE ELECTRICAL TREATMENT OF SEEDS.

During the past seven or eight years, experiments have been in progress upon the effect of the electrical treatment of seeds. The process is one devised by Dr. Charles Mercier who, however, recently died, but the work is being carried on by others. It is only during the past three years that the process has been worked on a commercial scale. Three seasons ago it was tried at home by about a dozen farmers, two seasons ago by more than 150, and this season by more than 500. The process has not been advertised and the rapid progress made is almost entirely due to the recommendation of one farmer to another, or by seedsmen to farmers. It is claimed for the process that properly conducted electrification of seed never fails to produce an increase in a crop of corn, and that in every one of the few cases in which this result has not been produced, it has been found that some mistake has been made in the process. From samples of wheat, oats, barley, etc., the writer has seen there is a distinct improvement in that grown from electrified seed over that grown from seed in the ordinary way. The figures given to him were that the increase in yield varies from four bushels to twenty or more bushels per acre, the average of a considerable number of trials being about ten bushels or 30 per cent. Engineers indicate that there is considerable difference of opinion and in some cases scepticism as to the results of electrification. It seems a curious fact that laboratory experiments at the experimental farm at Rothamsted shew no improvement from electrified seed, whilst a number of farmers from the Devonshire district are ready to speak in high praise of the value of the process. The owners of the process say that every kind of seed requires its own peculiar treatment, and that this treatment has been completely ascertained only for cereal crops. Large quantities of electrified root seeds have, however, been sown this season. The general claims are that the cost of

electrification is small, the process is simple and adds nothing to the labour of the farmer, to the implements for operation on the farm or to his capital on outlay, unless he chooses to electrify the seed for himself. [*Indian Industries and Power*, November 1919.]

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Flour from the cattails of the swamps has been found by the Plant Chemical Laboratory at Washington to contain about the same amount of protein as rice and cornflours, with somewhat less fat than wheat flour, and it was regarded as a promising substitute with wheat flour to the extent of 10 to 20 per cent. In the investigation of which he has given an account in the "Scientific Monthly," Prof. P. W. Claassen tried the flour in several ways, both as part substitute with wheat flour in baking and as cornstarch substitute for puddings. Biscuits containing 50 and even 100 per cent. of this flour proved to be palatable, not very different from those of wheat flour alone, while the puddings had an agreeable flavour and were satisfactory. The flour material is obtained from the large underground rootstalks or rhizomes, of which it forms a starch core three-eighths to one-half inch in diameter. The dried rhizomes from an acre of cattails were shown to equal 10,792 pounds, and the core substance, passed through a meat-grinder and sifted, yielded fine flour at the rate of 5,500 pounds per acre. Many thousand acres of cattail marshes are included in the 139,855 square miles of swamp-land of the United States. [*Capital*, dated 10th January, 1920.]

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MANGO HOPPER PEST.

A COMMUNIQUE issued by the Publicity Bureau, Madras, says :—

THE Government Entomologist of the Agricultural College, Coimbatore, notifies that he is in a position to supply fishoil rosin soap at the rate of R. 0-2-1 per lb. This should be used to spray mango trees to save them from the mango hopper. A pamphlet containing instructions showing how the soap should be applied,

will be sent free of charge to any tree owner who applies to the Government Entomologist, Agricultural College, Coimbatore. The tree owners living in Northern Circars can obtain the soap and the pamphlet by applying to the Deputy Director of Agriculture, No. 1 Circle, Anakapalle.

A later communiqué from the same source says :—

One of the worst enemies of the mango tree is the insect called "the mango hopper" which causes considerable damage to the crop in certain years, especially in Chittoor and Salem. Sometimes the trees in the gardens blossom in profusion during the cold weather, and great hopes are entertained of a good crop in the coming season. But within a week or two after blossoming, the flower buds and blossoms turn brownish and gradually wither away. The few first formed fruits drop and the leaves of the mango become covered with a sticky juice which gives them a dark sickly appearance. The cause of the trouble is the mango hopper.

The mango hopper is a small insect about an eighth of an inch in length with a broad head and a wedge-shaped body. Its colour appears to be a light greenish brown. Close observation shows that it is really brown with light black and yellow markings. It can fly but generally moves about by vigorous hops. The insect lays its eggs in the shoots and leaves, inserting them one by one beneath the surface. The eggs are almost too small to be seen by the eye. The young are similar to their parents but wingless. They cast their skins periodically and get their wings and their full adult form in about 10 days. Both the young and the full-grown insects attack the tender shoots and leaves of the mango and suck up the plant sap, thereby robbing the flowers and fruit of the juice required to develop them. These insects breed at the time when the mango trees blossom, and in some years enormous swarms of mango hoppers may be found in the mango trees at the blossoming season. If these swarms are allowed to have their way there is no hope for the mango fruits.

The only generally effective method of defeating the attacks of mango hopper is to spray the trees at the breeding season with some liquid which will kill the young hopper. Young hoppers

are wingless and are unable to fly or hop. Hence they are unable to escape from the poisonous spray. The spraying operation must be begun when the flowering shoots begin to appear, *i.e.*, about January, and must be repeated from time to time up to the end of March. The possibility of defeating the attacks of the mango hopper by the use of a spray has been tested and proved by the Agricultural Department in experiments conducted for some years in the mango gardens of Salem and Chittoor.

The Agricultural Department has published a leaflet (No. 3 of 1917) giving detailed instructions for the use of the spray. The material recommended by the Agricultural Department for use as a spray is the fishoil rosin soap. To use the spray we need a good syringe which will wet the tree evenly all over. An ordinary garden syringe is not generally satisfactory and a special syringe is required.

The cost of a suitable syringe would probably be about Rs. 100. The cost of fishoil rosin soap required for spraying a single mango tree may roughly be taken as 8 annas. A single syringe will of course spray a very large number of trees. As the crop of a single mango tree may be worth 200 or 300 rupees, it will be seen that the tree owner can well afford to invest some money in a suitable syringe and the fishoil rosin soap. It has been suggested that traders or co-operative societies in Chittoor and Salem might well buy suitable syringes and hire them out at reasonable prices to the tree owners in their neighbourhoods. The Government Entomologist of the Agricultural College, Coimbatore, has already notified that he has a stock of fishoil rosin soap for sale and that he is prepared to supply with the soap pamphlets containing instructions for its use and advice as to the most suitable spraying machines for the work and the firms and prices at which they can be purchased.

It is understood that many tree owners have shown their willingness to adopt the system of spraying, and it might be worth while for a commercial firm to stock and advertise a suitable mango syringe after consulting the Agricultural Department and obtaining its approval to the type of syringe.

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

SIR FRANK SLY, K.C.S.I., I.C.S., who officiated as Inspector General of Agriculture in India from 1904 to 1907, has been appointed Chief Commissioner of the Central Provinces. We offer him our sincere congratulations.

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WE offer hearty felicitations to the Hon'ble Mr. H. R. C. Hailey, C.I.E., I.C.S., Director of Land Records and Agriculture, United Provinces, and Mr. Frank Noyce, I.C.S., Controller of Cotton Cloth, who have been appointed Commanders of the Most Excellent Order of the British Empire (Civil Division) for services in connection with the war.

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THE New Year's Honours List contains the following names which will be of interest to the Agricultural Department:—

Rai Bahadur. Babu RAJESWAR DAS GUPTA, Deputy Director of Agriculture, Bengal.

Mr. LACHMI CHAND SHARMA, M.R.A.C., Deputy Director of Agriculture, Eastern Circle, United Provinces.

Khan Sahib. Shaikh MUHAMMAD NAIB HUSSAIN, Superintendent, Sugarcane Farm, Shahjahanpur, United Provinces.

M. NAIZ MUHAMMAD, Deputy Superintendent, Civil Veterinary Department, United Provinces.

Rai Sahib. Babu APURBA KUMAR GHOSH, Sericultural Superintendent, Bengal.

Rao Sahib. M. R. Ry. T. S. VENKATRAMAN, B.A., Acting Government Sugarcane Expert, Coimbatore.

M. R. Ry. Y. RAMACHANDRA RAO, M.A., F.E.S., Entomological Assistant, Agricultural Department, Madras.

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SIR THOMAS ELLIOTT, Bart., K.C.B., has been appointed as the representative of the United Kingdom, India, and other parts of the British Empire on the Permanent Committee of the International Institute of Agriculture at Rome.

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MR. G. P. HECTOR, M.A., B.Sc., Economic Botanist, Bengal, has been appointed to officiate as Imperial Economic Botanist, Pusa, from 20th December, 1919, *vice* Mr. A. Howard, C.I.E., M.A., on combined leave.

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DR. F. J. F. SHAW, Second Imperial Mycologist, has been granted combined leave for 11 months.

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THE University of Calcutta has conferred the degree of D.Sc. (in Chemistry) on Mr. J. Sen, Supernumerary Agricultural Chemist, and the degree of M.Sc. (in Chemistry) has been conferred on Mr. N. V. Joshi, First Assistant to the Imperial Agricultural Bacteriologist, by the Bombay University.

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MR. T. F. MAIN, B.Sc., Deputy Director of Agriculture, Bombay, has been allowed an extension of furlough for six months.

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MR. K. HEWLETT, O.B.E., Principal, Bombay Veterinary College, has been granted combined leave for six months. Mr. M. H. Sowerby officiates as Principal during Mr. Hewlett's absence.

MR. R. D. ANSTEAD, M.A., Deputy Director of Agriculture, Planting Districts, Madras, has been granted combined leave for one year from or after 10th April, 1920. Mr. F. R. Parnell, B.A., Government Economic Botanist, will, on return from leave, be entrusted with the supervision and control of the experimental work at the planting stations.

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MR. H. M. LEAKE, M.A., F.L.S., Offg. Director of Agriculture, United Provinces, has been nominated a member of the Legislative Council of the Lieutenant-Governor of the United Provinces.

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DR. A. E. PARR, M.A., B.Sc., Deputy Director of Agriculture, Western Circle, United Provinces, was on privilege leave from the 11th October, 1919, to the 5th January, 1920.

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MR. D. CLOUSTON, C.I.E., M.A., B.Sc., has been confirmed as Director of Agriculture, Central Provinces.

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MR. R. G. ALLAN, M.A., Principal, Agricultural College, Nagpur, has been granted privilege leave for six months. Mr. F. J. Plymen, A.C.G.I., will officiate as Principal during the absence on leave of Mr. Allan, or until further orders.

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MR. C. P. MAYADAS, M.A., B.Sc., Assistant Director of Agriculture, Western Circle, Central Provinces, is appointed to officiate as Deputy Director of Agriculture of the same circle, *vice* Mr. F. J. Plymen.

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MR. J. H. RITCHIE, M.A., B.Sc., Deputy Director of Agriculture, Northern Circle, Central Provinces. has been granted privilege leave for four months and 20 days. Mr. Nand Kishore, Extra Assistant Director of Agriculture, has been appointed to officiate until further orders.

Mr. O. T. Faulkner, B.A., Deputy Director of Agriculture, Lyallpur, has, on return from leave, resumed charge of his duties, relieving Malik Sultan Ali who remains attached to the Punjab Agricultural College.

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Captain K. J. S. Dowland, M.R.C.V.S., has been appointed to the Indian Civil Veterinary Department, and is posted to the Punjab as Professor of Sanitary Science, Punjab Veterinary College, Lahore.

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Mr. E. Sewell, M.R.C.V.S., has been appointed Post-Graduate Professor in the Punjab Veterinary College.

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Mr. F. J. Warth, M.Sc., Agricultural Chemist, Burma, was granted an extension of combined leave up to the 31st January, 1920.

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Mr. W. Harris, M.R.C.V.S., Superintendent, Civil Veterinary Department, Assam, has been granted leave for one month and sixteen days in extension of the leave already granted to him.

WOODHOUSE-SOUTHERN MEMORIAL FUND.

	Rs.
Donations received up to the 30th November, 1919, and acknowledged in the *Agricultural Journal of India,* Vol. XV, Pt. I, January 1920	2,562
Sardar Darshan Singh (S)	20
Total Rs.	2,582

Reviews

Botany for Agricultural Students.—By J. N. MARTIN. (New York: Wiley & Sons.)

Botany of Crop Plants.—By W. W. ROBBINS. (Philadelphia: P. Blakistons Son & Co.)

THE author of the first book states in his preface that his aim has been to present the fundamental principles of botany with emphasis on the practical application of these principles, chiefly to farm crops, forestry and horticulture. With this object, he deals in the first part of the book with the general structure and functions of plants, and in the second with particular types of plants, from thallophytes to gymnosperms, arranged according to their evolutionary relationships; while the book ends with short chapters on the adaptation of plants to their environment, on evolution, variation and heredity, and the application of these to plant improvement.

To the agricultural student, the value of the book lies chiefly in the fact that economic plants are mainly used as illustrative material, and in this respect the book will be of use to students in this country, as the types described are generally more familiar than those usually presented in English text-books. For example, in the first part maize is fully described, and the illustrations showing the structure of the flower and other parts of this cereal are among the best in the book.

There are some notable omissions from the index. Though much attention is naturally given to wheat in the text, there is no mention of it in the index, either under its botanical or common names.

The second book is of a different nature to the first. While the first is a botanical text-book, the latter is more suitable to the student who has already undergone a course in general botany and wishes to take up the more detailed study, from a botanical and agricultural point of view, of particular crops. While it deals briefly in the introductory chapters with the main structure and functions of plants, chiefly with the view of rubbing up previously acquired knowledge, the main part of the book is devoted to chapters dealing with the botany, agriculture and economics of the chief crops familiar to the American student. In this way it deals with the chief cereal crops, fibre plants, oil-seeds, fruits, vegetables and condiments. The various groups of plants are preceded by a botanical description of the natural order to which they belong, and the chapters end with references to the most recent literature regarding the crop in question, which are fairly full and up-to-date. The book is well illustrated and is a useful addition to the list of text-books in English dealing with the botany of cultivated plants. [G. P. H.]

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Drainage for Plantations : A Practical Handbook.—By Claud Bald. (Calcutta : Thacker, Spink & Co.)

" DRAINAGE is now looked upon as the foundation upon which all other agricultural improvements must be based."

Everyone knows in a sort of casual way that drainage is necessary in certain soils and that no soil which is permanently saturated with water will produce good crops. A swamp, for instance, is unproductive. In arranging any system of drainage stagnant water must at all costs be eliminated. What is needed is a constant and fairly rapid flow of an even sheet of water through the soil which is followed by air, thus aerating the roots of plants in the soil as well as leaving the soil particles surrounded by water films from which the roots can obtain the water they need.

" It is a mistake to suppose that drainage carries away all the water out of the soil. It only carries off surplus water. The water which is held by capillary attraction and water films are retained

no matter how much the land is drained. If the land is not in a well drained condition the rain cannot enter the soil further than an inch or two, and consequently most of the rain must flow off the surface, carrying with it nearly all the fertilizing properties and also a great deal of surface soil and organic matter which has been weathered and prepared for plant food, all being lost and carried away in streams and rivers. On the other hand, wherever the soil is in a good state of drainage most of the rain passes through the surface soil leaving behind it the valuable fertility which it carried. This water also carries down with it the air which had been occupying the vacant spaces between the soil particles."

The benefits to be obtained from drainage are wider than even this, and it is an agricultural operation which does not always receive the attention which it should. One aspect of drainage which is often lost sight of is its effect upon diseases. Thus "Red Rust," a disease of tea due to the parasitic growth of an alga, is due to want of drainage to a very large extent. If the soil is drained and the root system of the tea deepened the disease disappears. More recently the Acting Chief Scientific Officer and the Entomologist of the Indian Tea Association have published a report on Tea Mosquito Blight, caused by an insect known as *Helopeltis*, in which they point out that an important factor of the disease is the question of soil water-logging, and they advise a good drainage system as one method of dealing with the pest.

The handy little book which has been quoted above will be found a most useful addition to the library of every agriculturalist, setting forth as it does the principles of drainage, and the methods which can be adopted to attain it, in a condensed form and simple language. The author, who is well known for his excellent book on "Indian Tea," has been most successful in his object of giving a summary of points necessary for planters who require scientific data on this subject in a condensed and handy form. [R. D. A.]

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. The Ecological Relations of Roots, by Prof. J. E. Weaver. Pp. vii+128+30. (Washington: Carnegie Institution.)
2. Agriculture and Farming Business, by O. H. Benson and George Herbert Betts. Pp. xvii+778. (London: Kegan Paul, Trench, Trubner & Co., Ltd.) Price, 10*s*. 6*d*. net.
3. Introduction to Physical Chemistry, by Prof. James Walker. Eighth edition. Pp. xiii+433. (London: Macmillan & Co., Ltd.) Price, 16*s*. net.
4. The Chemical Chemistry of the Proteins, by T. Brailsford Robertson. (London: Longman, Green & Co.) Price, 25*s*. net.
5. A Course of Practical Chemistry for Agricultural Students, by H. A. D. Neville and L. F. Newman. Vol. II, Pt. I. Pp. 122. (Cambridge: At the University Press.) Price, 5*s*. net.
6. Commercial Oils: Vegetable and Animal, with a special reference to Oriental Oils, by I. F. Laucks. Pp. viii+138. (London: Chapman & Hall.) Price, 6*s*. net.
7. Applied Botany, by G. S. M. Ellis. Pp. viii+248. (London: Hodder & Stoughton.) Price, 4*s*. 6*d*. net.
8. Elementary Biology, by B. C. Gruenberg. Pp. x+528. (Boston & London: Grinn & Co.) Price, 7*s*. net.
9. Science and Fruit-growing, being an account of the results obtained at the Woburn Experimental Fruit Farm since its foundation in 1894, by the Duke of Bedford, K.G., F.R.S., and Spencer Pickering, M.A., F.R.S. (London: Macmillan & Co. Ltd.) Price, 12*s*. 6*d*. net.
10. Experiments with Plants, by J. B. Philips. Pp. 207. (Oxford: At the Clarendon Press.) Price, 3*s*. net.

11. Applied Chemistry, by Dr. C. K. Tuikler and H. Masters. Vol. I. Pp. xii+292. (London: Crosby Lockwood & Son.) Price, 12*s*. 6*d*. net.
12. Wonders of Insect Life, by J. H. Crabtree. Pp. vii+211+32 plates. (London: G. Routledge & Sons.) Price, 6*s*. net.
13. Popular Chemical Dictionary, by C. T. Kingzett. Pp. vi+368. (London: Baillière, Tindall & Cox.) Price, 12*s*. 6*d*. net.
14. A Manual of the Electro-Chemical Treatment of Seeds, by C. Mercier. Pp. 134. (London: University of London Press.) Price, 3*s*. 6*d*. net.
15. My Five-acre Holding, by M. Few. Pp. 164. (London: Hodder & Stoughton.) Price, 3*s*. 6*d*. net.
16. Mendelism, by R. C. Punnett. Fifth edition. Pp. 215. (London: Macmillan & Co., Ltd.) Price, 7*s*. 6*d*. net.
17. Commercial Poultry Farming, by T. W. Toovey. Pp. 140. (London: Crosby Lockwood & Son.) Price, 7*s*. 6*d*. net.

THE following publications have been issued by the Imperial Department of Agriculture in India since our last issue:—

Memoir.

1. Studies in the Pollination of Indian Crops. I, by A. Howard, C.I.E., M.A., Gabrielle L. C. Howard, M.A., and Abdur Rahman Khan. (Botanical Series, Vol. X, No. 5.) Price, R. 1-4 or 2*s*. 6*d*.

Reports.

1. Report on the Progress of Agriculture in India for the year 1918-19. Price, R. 1-4 or 2*s*.
2. Proceedings of the Board of Agriculture in India, held at Pusa on the 1st December, 1919, and following days (with Appendices). Price, As. 12 or 1*s*. 3*d*.

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3. Annual Report on the Progress of Agriculture in India.
4. Proceedings of the Board of Agriculture in India.
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8. Books.

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Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1918-19. Price, R. 1-4 or 2*s.*

Report on the Progress of Agriculture in India for the year 1917-18. Price, R. 1-8 or 2*s.* 3*d.*

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Proceedings of the Board of Agriculture in India, held at Pusa on the 1st December, 1919, and following days (with Appendices). Price, As. 12 or 1*s.* 3*d.*

Proceedings of the Second Meeting of Mycological Workers in India, held at Pusa on the 20th February, 1919, and following days. Price, As. 11 or 1*s.*

Proceedings of the First Meeting of Agricultural Chemists and Bacteriologists, held at Pusa on 24th February, 1919, and the following days. Price, R. 1 or 1*s.* 6*d.*

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